BELL TELEPHONE MAGAZINE

VOL. XX AUGUST, 1941 NO. 3

WESTERN ELECTRIC: TELEPHONE ARSENAL

NEW CHANNELS FOR OLD

EVOLUTION BY DESIGN

PROVIDING THE INFORMATION SERVICE

TELEPHONE STATISTICS OF THE WORLD

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

BELL TELEPHONE MAGAZINE

Continuing the BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

"The ideal and aim of the American Telephone and Telegraph Company and its Associated Companies is a telephone service for the nation, free, so far as humanly possible, from imperfections, errors, or delays, and enabling anyone anywhere to pick up a telephone and talk to anyone else anywhere else, clearly, quickly and at a reasonable cost."

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INSTEAD OF ALUMINUM

Dial telephones go through the assembly line as fast as ever, but the finger wheel is made of steel now—in place of the lighter metal. By substituting less critical materials in many ingenious ways, one Western Electric plant alone is saving an estimated million pounds of aluminum this year, and similar savings are being made at the other W. E. Works, as well as in other vital metals and alloys—

as described in the article beginning on the opposite page

WESTERN ELECTRIC: TELEPHONE ARSENAL

The Bell System's "Service of Supply," Experienced in Meeting Emergencies Imposed by Nature's Forces, Is Geared Up to Serve the Nation in This Time of Crisis

By ALVIN von AUW

The following article discusses the part being played in the nation's defense effort by the Western Electric Company, which is the manufacturing, purchasing, and distributing unit of the Bell System. More general statements of the System's rôle in the re-armament program have appeared in three previous issues of this magazine: October, 1940, *the text of a brief radio broadcast by President Walter S. Gifford of the A. T. and T. Company over a nation-wide network on October 14;* February, 1941, *"The Bell System and National Defense"; and* May, 1941, *the statement to stockholders by Mr. Gifford at the annual meeting on April 16.*

In the re-armament program in which this country is so mightily engaged, the Western Electric Company is a full partner. For vital to the nation's defense effort is coördination, which depends, in turn, upon communications. And communications means the telephone. The telephone network has become the nerve system of a democracy on guard against the perils of a world at war. Recent months have seen a demand on the services of the Bell System, and thus on the manufacturing facilities of the Western Electric Company, unprecedented in the history of the telephone. Today the products of Western Electric are moving up to the defense front in an ever-mounting stream.*

Military analogies are apt. In these recent crowded months Western Electric has become the arsenal of telephony. For many years Western Electric has been termed the Bell System's "service of supply," a phrase borrowed from the armed forces. The W. E. organization was established and is maintained to secure the advantages of standardized manufacture and of large-scale centralized purchasing coördinated with nation-wide distributing and equipment installation forces—all in order to supply a communications front stretching the length and breadth of our country. In emergency after emergency this type of organization has demonstrated its advantages. Today, in an "unlimited national emergency," they are once more apparent.

* So, of course, are the products of other manufacturers of communication equipment, who supply in large part the needs of the country's 6,400 independent Bell-connecting telephone companies. Many of them are also working on defense contracts directly for the armed forces. See "Independent Telephone Companies," MAGAZINE, May, 1941.

PLANNING COMES FIRST

In all Western Electric plants, engineering conferences are a basic preliminary to the production of communication equipment for the nation's defense

Western Electric's defense effort is two-fold. The Company has thrown its full weight of man-power and machines into (1) the manufacture of radio and other communication items for the Army, the Navy, and the Air Corps, and (2) the engineering, manufacture, and installation of telephone equipment ordered through the Bell System operating companies for service in government defense establishments, in vital privately-owned defense plants, in Bell System central offices and cross-country circuits expanding to meet the communications demands of a nation girding itself for any eventuality.

The Bell System laid the groundwork for its defense activities well in advance of the first huge defense appropriations. Telephone company and Western Electric men organized regional defense committees to speed local activities. In New York, the headquarters defense-program group includes a W. E. "coördinator" as one of its important members. To the coordinator's desk has come a mounting stream of teletype "flashes" from the field and from the Bell System representatives in Washington as well: ". . . $25,000,000 NAVAL AIR BASE FOR QUONSETT POINT RHODE ISLAND FOR SERVICE MAY 1 AT LEAST 500 DIAL PBX LINES REQUIRED. . . . TANK ARSENAL SLATED FOR DETROIT 40,000 FEET LEAD COVERED CABLE SHIPMENT REQUIRED AT ONCE. . . . SAN DIEGO CONSOLIDATED

AIRCRAFT 600 PBX LINES BY MAY 1 200 LATER. . . ." Advance information like this, carefully collated, helps the Company to anticipate the later and more specific demands and to make corresponding preparatory adjustments in production programs all along the line.

Cryptic initials "A. S. A. P." (for "as soon as possible") give a staccato touch to many telephone company orders for W. E. material. On corresponding Western Electric invoices, the notation "shipped same day" recurs with gratifying frequency. On specific defense orders, normal "engineer, furnish and install" schedules have been telescoped. Cable reels may roll into army camps when they're little more than a stack of blue-prints in a contractor's shack. Private branch exchanges are often cut into service while the big bulldozers are still making molehills out of mountains, clearing the ground for Uncle Sam's military cities. By the time a camp crackles with its first bursts of practice rifle fire, an entire telephone system will have been installed, and telephones are ringing in headquarters' offices.

Production Quantities Are Vast

WESTERN ELECTRIC's finger on the pulse of the defense situation is the program planning group at headquarters. Twice monthly the group issues a detailed report of progress

THIS IS A FLIER-STRANDER

At the rate of 600 feet a minute, 101 separate pairs of wires are drawn from spools through the drilled plate and stranded together—one step in the manufacture of telephone cable

along the communications front, together with carefully considered estimates of future requirements. How many telephones are needed in the building of a two-ocean navy, an army of a million and a half, an air force second to none? How much cable? How many PBX's? These reports chart the rapidity with which Western Electric's production, delivery, and equipment installation schedules must be revised in step with the fast expanding defense program. Last October some 153 army, navy, and other defense establishments were projected or a-building. By December 136 more had been added. In February the total reached 777. Today the number is approaching 1,100. To nearly all of these army camps, navy yards, airfields, arsenals, anti-aircraft firing centers, etc., Western Electric will provide telephone equipment in whole or in part—or has already done it.

To do the job, current estimates indicate, will require 9,191,000,000 conductor feet of lead-covered cable, 629 private branch exchanges, 10,000 public telephones, 8000 booths, 3200 teletypewriters — and corresponding totals for other major and miscellaneous items.

But these figures cover only equipment destined for installation in army camps, naval bases, airfields, arsenals, and other government-owned or government-financed defense establishments. They do not take into account equipment required for the Bell Sys-

FIELD TELEPHONES FOR THE ARMY

Skilled fingers assemble in mass production the sturdy sets which may handle vital orders and reports in action

LEARNING THE TECHNIQUES OF INDUSTRY
Students in the training department at Hawthorne Works receive some pointers on the operation of a tool-and-die machine

tem's greatly expanded program of new construction. The rapidly growing communications requirements of private industry and of the thousands of America's new homes, as well as the equipment needed to increase the capacity of hundreds of telephone central offices, to add many circuits between the great industrial centers of the land, to link suddenly booming communities to the nation-wide telephone network—all these have placed a demand on the production capacity of Western Electric unmatched in the Company's 72-year history.

ALL the Company's plants are running at exceptionally high annual production rates in almost every line of communications equipment. A check of central office apparatus production shows current annual "going rates" of 116,000 lines of panel, 584,000 lines of step-by-step, 303,000 lines of crossbar. Manual central office equipment is running at the rate of 2,090 switchboard positions per year. Sales of carrier and repeater equipment, items for which there is a heavy demand to supplement the long-distance facilities now serving the nation-wide preparedness program, are expected to reach a total of $22,600,000 for 1941. The loading coil going rate is currently set at 1,227,000; telephone sets at 2,870,000; dials at 1,980,000. Rubber-cov-

CABLES FOR EVERYWHERE

By water, by rail, and over the road these reels of lead-covered cable—already tested, sealed, and packed—will speed to points throughout the country where an expanding telephone service requires them

ered wire is being turned out at the rate of 2,156,000,000 conductor feet per year. Cable shops are working at an annual rate of 48,850,000,000 conductor feet. Much of this lead-sheathed cable is being armored, at an annual rate of more than 5,000 miles a year, for protection against the elements and marauding rodents when buried along underground toll routes.

ANOTHER example of advance planning is Western Electric's program of conservation of vital raw materials. For some years, Bell System engineers have been studying materials, both old and new, to assure their most effective use, and today these studies are proving of great value in the light of present problems of supply. In Western Electric plants, less critical materials are now being substituted for metals and alloys vital to airplane and munitions manufacture. Engineers at the Hawthorne Works estimate that the substitution program will effect a saving of more than a million pounds of aluminum in 1941—approximately 62 per cent of the amount this one plant alone would otherwise use. Impressive savings are also being effected at all Western Electric Works with other critical materials as well—nickel, zinc, nickel-steel, magnesium, etc.

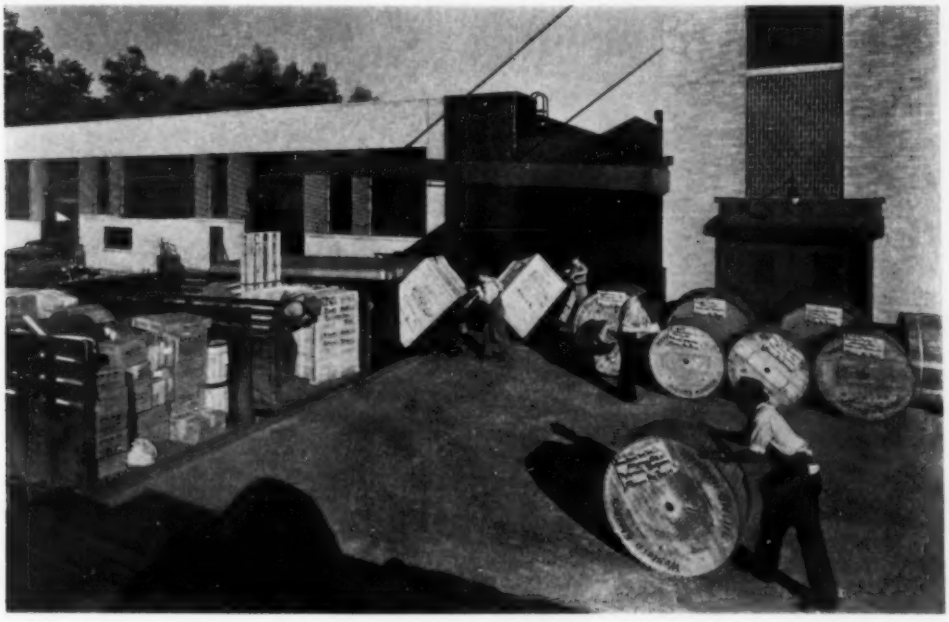
In twelve months the Western's man power has increased nearly 50 per cent. Since June of 1940 more

than 16,000 new employees have taken their places beside the old, learning from them the tricks of their trade and absorbing the spirit of service. The Western's training programs, too, are bearing fruit, relieving somewhat the acute shortage of machinists and skilled operators which was forecast as a potential defense stumbling-block. Western Electric, like many another vital defense industry, is burning midnight oil: extra shifts in key departments are contributing heavily to the Company's total defense effort.

W. E. in Action

You can't tell the story of action on the communications sector with generalizations and statistics alone. You have to go into the front lines. You have to see, for instance, a crew of installers rolling out of improvised bunks in an unheated, unfinished army barracks to complete an elaborate PBX installation before the troops arrive. You have to see the conveyor systems in the Western's 29 distributing houses disgorging material labeled "National Defense." You have to see the men and women and machines of Hawthorne, Kearny, Point Breeze, and the other W. E. plants in action. You have to visit one of Uncle Sam's vast new Army camps.

Take Camp Blanding, for instance, Florida's fifth largest "city," population 45,000. Twelve months ago the uninhabited 55,000-acre tract was given over to palms and pines and an impenetrable thicket.



FOR AN AIR BASE AND TWO ARMY CAMPS

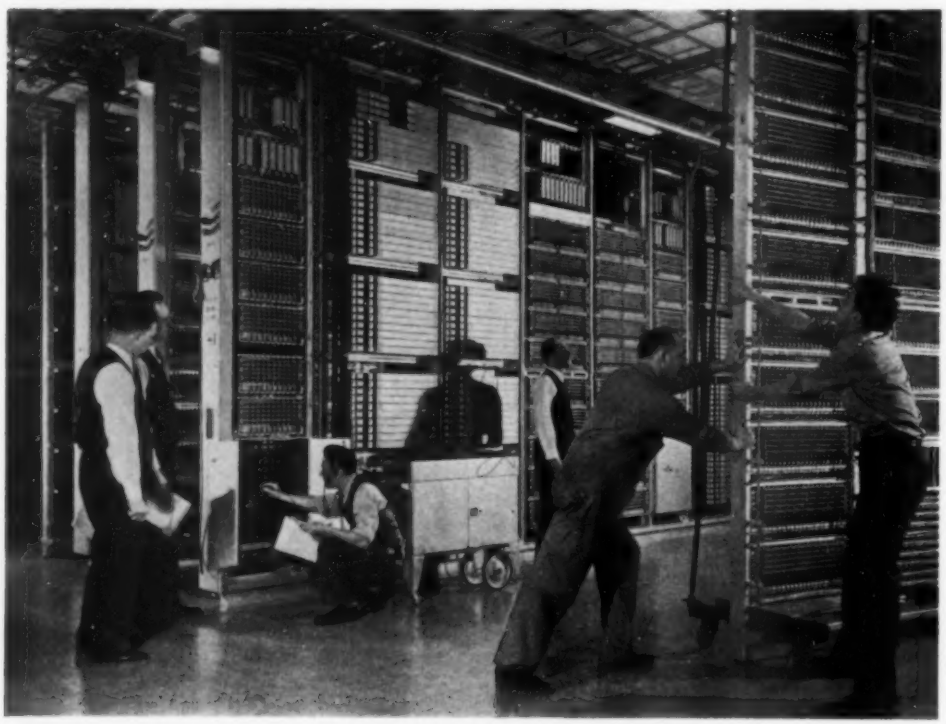
Cable, switchboard sections, and miscellaneous equipment are leaving the loading dock of a Western Electric Distributing House. With a magnifying glass, the words "National Defense" can be seen on every address label

Nearest community to Blanding is Starke, 30 air miles south of Jacksonville. A year ago Starke awoke with a jolt. Twenty-two thousand workmen came to town. In a week cot-space was at a premium. A boom town overnight, Starke went to work in earnest for defense.

On October 26, 1940, the first flag went up over the soldier city. Work crews knocked off for a few minutes to gaze at the banner, then set to again at the double. Early in December the troops began to roll in by train and truck. Based at Blanding today are two full Infantry divisions and a Field Artillery brigade.

To provide communications facilities for the mushrooming military city, the Bell System matched strides with Uncle Sam.

Pine trees hadn't yet given way to barracks when the Southern Bell Telephone and Telegraph Company rushed the first temporary PBX to Blanding. It was set up in the contractor's office, an Army kitchen, and connected with Starke over a two-bracket line rigged by the National Guard. Two weeks later, while carpenters were still hammering away on the rooftop, an 80 line PBX from Western Electric's Jacksonville distributing house was cut into service



A WASHINGTON CENTRAL OFFICE EXPANDS

Western Electric installers are placing dial switching equipment to care for the Capital's vastly increasing numbers of telephone calls. Many central offices have been greatly enlarged to care for the traffic occasioned by the defense program

ARMY FIELD EXERCISES

A permanently installed dial-type switchboard in the front of the truck is linked to smaller Command Post switchboards ahead and to larger units at the rear. So functionally designed is this equipment that telephone facilities to serve a relatively large sector can be completely set up, including the running of field wire, in a few minutes

in the temporary administration building. Later the contractor called for, and got, 80 more lines.

At September's end, Southern Bell ordered from Western Electric sufficient wire to increase the number of circuits between Jacksonville and Starke from three to nine, the circuits between Starke and Gainesville from two to six. (Circuits between Starke and Jacksonville have since been increased to 22.) Western Electric was also called upon for four positions of number 12 switchboard for the new central office at Starke. Within ten days after the order was dispatched, the switchboard had been engineered and the first shipment had been received. On October 10 a Western Electric installation crew rolled into Starke. On November 18 they rolled out again, the central office installation completed.

Completed is hardly the word, though; for within a few weeks Western Electric men were back on the job to answer the call for three more switchboard positions. Then, later, four more positions were added. And recently the installation of ten additional switchboard positions has brought the total in the new Starke central office to 21.

Meantime, Southern Bell men were burying 43,900 feet of 76-pair cable in the sandy soil between town and camp.

Meantime, too, workmen rushed

A PRIVATE BRANCH EXCHANGE SWITCHBOARD

This one serves a naval operating base. Other hundreds of P.B.X.'s, large and small, have gone into camps and bases and into industrial plants from coast to coast

Building TT-2 toward completion. They had a deadline to meet. On December 7, as the camp for the first time echoed to the tread of marching feet, Western Electric installers turned TT-2 into a military nerve center by cutting into service a seven-position, 400-line PBX switchboard.

Since Blanding opened for business, the camp's PBX has been increased to ten positions and its capacity has soared to 1300 lines; cable requirements have lifted radically; public telephones for the convenience of soldiers off duty have been installed.

Blanding, for all its jig-time construction, is not unique. Although one of the largest, it is in point of fact typical of the scores of defense establishments, located at a distance from sizable communications centers, which must be fitted with complete telephone facilities in the interest of national security.

At Corpus Christi

HERE's another example.

At Corpus Christi, Texas, close by the Mexican border, there stands a brand-new $44,000,000 assembly-line six months long. Today it is turning out America's most urgent defense weapons: flying men—300 of them a month. It's the world's largest naval air station. Yesterday, it seems, it was a waste of sand dunes and mesquite. With a total acreage of 14,500, Corpus Christi has 29 sepa-

"—WITH THE GREATEST OF EASE"

Conversation with ground stations and with other ships in flight is vital to this pilot of one of the celebrated Army P-40's. Note the throat microphone, which transmits the voice clearly but not motor and other extraneous noises

rate air fields. Twenty-five are practice landing fields scattered over two counties. Only the main base and three auxiliary fields are edged with dormitories and administration buildings, however, so that the huge air campus will have four separate dial PBX systems—an 800-line 701-A PBX with five 605-A positions for the main base, two unattended 100-line 711-A's and a single-position 701-A for the auxiliary fields. Will have? On June 7 all four PBX's went into service simultaneously, six weeks after Western Electric installers put in their first appearance.

Equipment for the main base was ordered April 9, shipped on the 23rd. Installation began on the 28th. Western Electric's two Texas distributing houses established a record, too, by shipping poles, cable, and five positions of manual PBX to provide telephone facilities preliminary to the official dedication of the base last March 12. Moreover, W. E. men have installed six new toll positions in Corpus Christi's central office, an added capacity that in normal times would provide for growth over a period of some years.

Air-base telephone communication is, necessarily, highly versatile. The elaborate crash alarm system at Corpus Christi will send crash boats, ambulances, crash wagons racing to the rescue inside a minute and a half after an accident report is received.

Corpus Christi and Blanding have been cited here in some detail not because they're unusual, but because they aren't:—that is, in reference to military construction which is being accomplished in many places throughout the country. Multiply these two instances by the total defense picture and you have the reason for unprecedented production figures at Hawthorne, Kearny, and Point Breeze, for the accelerated pace of distributing house service, for new installation records.

For the Armed Forces

CORPUS CHRISTI and its swarms of canary-colored primary trainers—"yellow perils" in cadet slang—call to mind another Western Electric defense contribution.

Backed by Bell Telephone Laboratories and a quarter century of aviation radio experience, Western Electric, with little or no fanfare, has been turning out radio telephone equipment used by all major United States airlines and hundreds of private fliers. That experience is bearing fruit today. The Specialty Products Division at Kearny has Government orders approaching a total of $100,000,000, a major share of which is for light-weight, low-powered aviation radio equipment for installation in America's rapidly multiplying squadrons of training and fighting planes. The balance of these orders calls for high-powered radio equipment for use on the ground, and also for special telephone, amplifier, and loudspeaking equipment for installation on the new battleships, cruisers, and aircraft carriers that are sliding from the ways in ever increasing numbers. Work on Specialty Products contracts is proceeding at all three Western Electric manufacturing locations, and, in line with the announced policy of the Office of Production Management, millions of dollars in sub-contracts have been let. Thus Western Electric's experience in the manufacture of broadcast transmitters, of radio telephones for use on land, on sea and in the air, and of public address systems and other miscellaneous items fits smoothly into the defense program.

WHAT the future may bring, no one can say with certainty. But as the present danger to democracy becomes more clearly seen—or, perhaps, better comprehended—surely this country's exertions to avert it will be redoubled. More and heavier demands will be made upon the Western Electric Company, as upon all industry: upon its plants and equipment, upon the resourcefulness of its management, and upon the loyalties of its employees. Along with all the other units of the Bell System, the Western Electric Company will continue to contribute in unstinted measure to the provision and maintenance of the country's essential communication service. Western has a job to do for national defense, and to the limit of its resources and capabilities it will keep on doing it.

NEW CHANNELS FOR OLD

To the People of Two Isolated Islands in Chesapeake Bay, a Recently Established Radio Telephone Circuit Brings Contact with the Bell System's Mainland Network

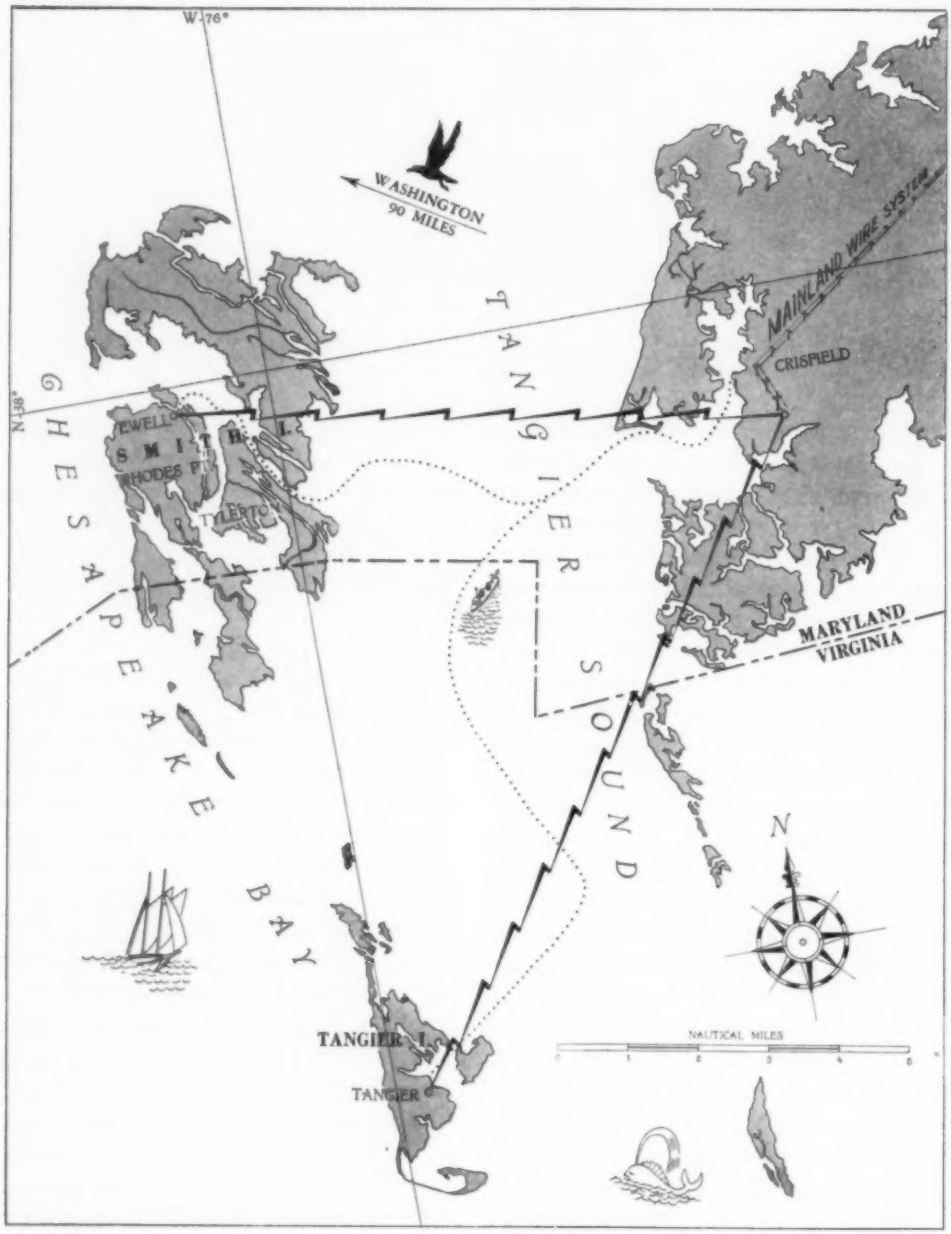
By EUSTACE FLORANCE and AUSTIN BAILEY

In the shallow waters of the Chesapeake Bay, 90 miles or so, as the crow flies, southeast of the dome of the United States Capitol, lie Smith and Tangier Islands. These islands were settled near the end of the seventeenth century, by English from the Colonies. Although these folk and their descendants have always been seafaring, they have had but infrequent contacts with their neighbors on the mainland. They have been fishermen, but the sea could not supply their every need. For two and a half centuries, summer and winter, the men of these islands have fought to keep open a sparse network of boat channels, their only outlet to the town of Crisfield, twelve miles away on Maryland's eastern shore. Through these channels, in sail boats, power boats, and barges flow all those commodities of commerce not taken from the sea that go to support 2,200 souls. Not all of this has been food and material things. Part of it has always been a precious freight of words, written or borne by messenger; words that asked and answered, that sought and gave help or comfort.

Shifting sands, strong winds, or choking ice sometimes blocked these channels; but even when the elements were friendly, the time and exertion required to convey a single word across the Bay was hardly less than would have brought a cargo of lumber or flour.

In recent years, while the islanders spent the seasons oystering and crabbing, caulking boats, or marking channels, others elsewhere explored and devised channels of a vastly different sort. It was inevitable that one of these new channels, dug out of the mystery of electricity by scientists in distant laboratories, should find a swift route above the boat channels to carry this traffic of words across the water barrier in calm or in storm.

The need for swift communication with the two islands had long been obvious. In years like 1936, when Chesapeake Bay froze almost solid, and even ice-breakers could not penetrate Tangier Sound, word spread abroad that aid was sorely needed by the residents of Smith and Tangier Islands. Then the Red Cross and Coast Guard coöperated to send succor to the starving islanders by airplane and parachute. Hazardous



THEIR ISOLATION ENDED

Radio telephone service now links Smith and Tangier Islands, in Chesapeake Bay, with the Bell System's wire network at Crisfield, on the eastern shore of Maryland

HARBOR AT TANGIER

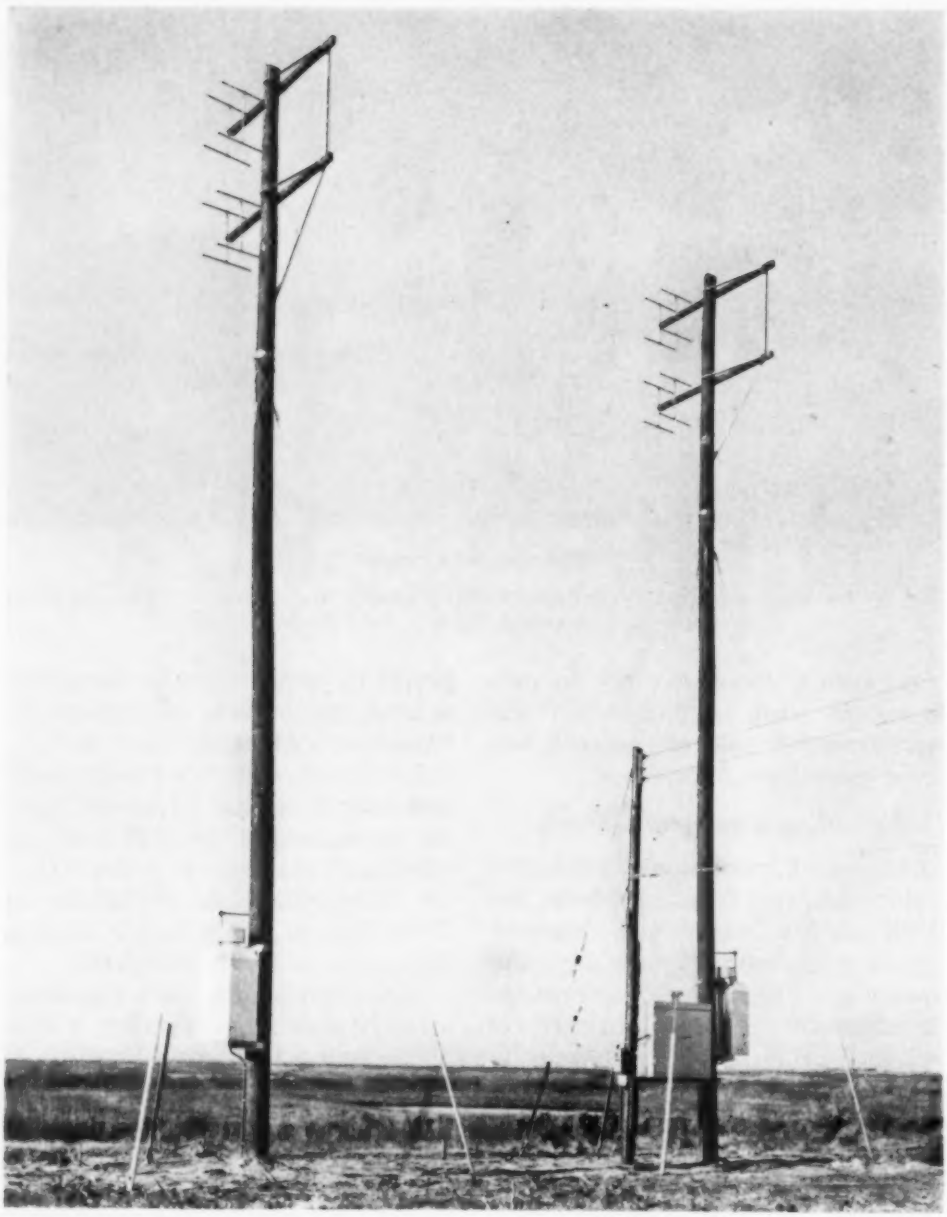
Bell System engineers came ashore here frequently during the past winter. The island was discovered and named by Captain John Smith in 1608

days such as these were not the only occasions when communication was sorely needed; but, of course, it was most essential at such times.

Providing Emergency Service

TELEPHONE connection by submarine cable had often been considered, but both shallow water and extensive oyster dredging would make any cable insecure. This fact led to repeated rejection by telephone engineers of all such cable projects. Progressive developments in the art of radio telephony suggested new approaches to the problem. As soon as suitable radio telephone equipment became available, the local telephone company made provision for at least the emergencies by establishing on the islands portable units for voice communication with the mainland. Restricted though it was, this service proved its worth: when ice threatened to block the channels, emergency calls summoned ice breakers from the U. S. Coast Guard, while other calls sought and secured medical advice or traced the movements of the mail boat and other craft that were over-due. During three months in the winter of 1939–40 alone, more than a hundred emergency calls were completed.

Much development work was necessary, however, to construct a telephone system that would be adequate for general commercial service: radio transmitters, radio receivers, and power supply that would operate continuously, dependably, and automatically with a minimum of supervision. Working together for nearly half a year, engineers of the Chesapeake and Potomac Telephone Companies, the Bell Telephone Laboratories, the Western Electric Company, and the



RADIO TELEPHONE EQUIPMENT ON THE MAINLAND

On these poles is the apparatus for communicating with the islands. Receiving antenna and equipment are on the pole at the left, and at the right are not only transmitting antenna and equipment but an automatically-operating emergency power supply

ON SMITH ISLAND

This is Main Street in Ewell. Since there are no vehicles larger than hand carts and bicycles here, this narrow "highway" is both safe and picturesque

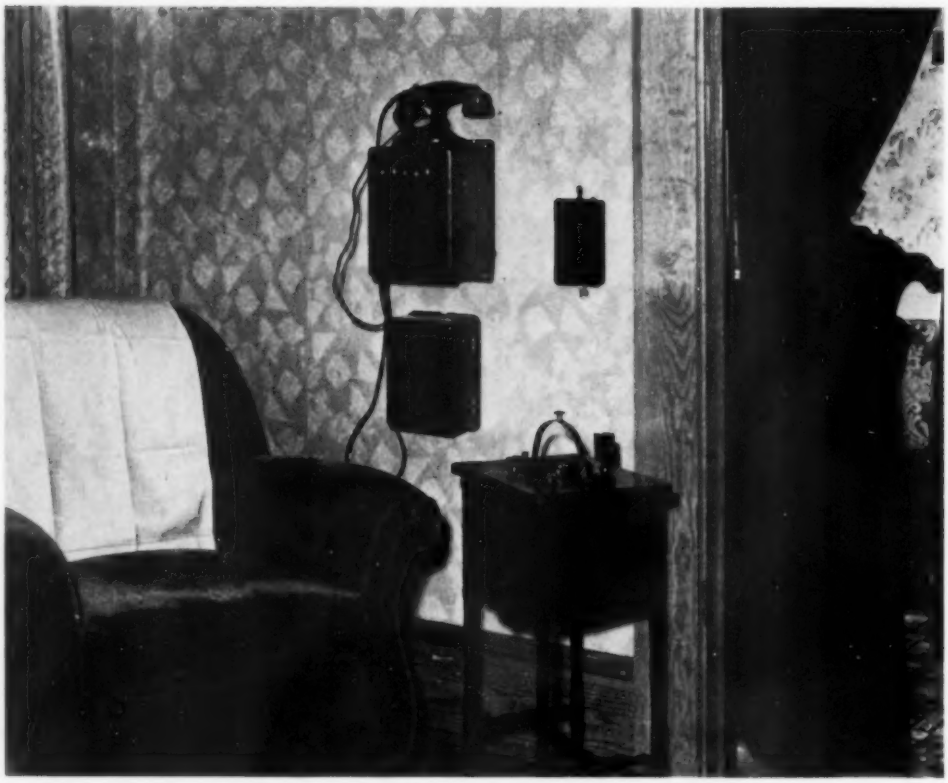
A. T. and T. Company devised such a system.

Many times during the past winter, often when the passage was coldest and windiest, telephone and Laboratories men visited the islands to direct the installation of equipment and to line up the circuits. As visitors are few on Smith or Tangier, Bell System men soon became known, and each step of the project had its interested audience.

Telephone Service at Last

LAST February, with the opening of a reliable radio telephone link which could be used for any messages, these two islands were connected with the nation-wide telephone network of the Bell System through the Crisfield telephone exchange. The radio link equipment consists of radio transmitters and receivers operating at frequencies around 160,000 kilocycles —the highest frequency in Bell System commercial radio telephony today. The channel is controlled from the Crisfield telephone office, and provides a circuit between Crisfield and Smith Island, Crisfield and Tangier Island, and between the two islands through Crisfield. In effect, a forked radio channel has been devised, engineered to cut the tine to one island when operating with the other.

The mainland radio station is in a marsh near Jenkins Creek, just outside the village of Crisfield. Here the equipment is all housed in pole boxes. The radio receiver is on one pole, which is likewise the support for the beam antenna used for receiving. The balance of the radio equipment—largely radio transmitter, control units, and beam transmitting antenna —is supported by another pole about



AN ISLAND TELEPHONE INSTALLATION

The switch at the right of the instrument on the wall gives access either to the radio telephone circuit to Crisfield or to the local wire circuit for conversation among the islanders

30 feet away from the first. Between this latter pole and a stub pole about 5 feet distant is a platform which supports an emergency power supply generator which will start automatically if there should be an interruption of the regular power.

On the islands other sixty-foot antenna poles, towering over the flat marshlands, disclose from afar the location of the sending and receiving apparatus and wholly automatic gasoline engines which generate the necessary power; all snugly fitted into diminutive huts which gleam white in new paint.

To give the inhabitants on the islands convenient access to the service, four telephones have been provided on each island, strategically placed in village store or dwelling. A flip of a key switches these instruments off the radio connection and onto a magneto line to furnish local talking facilities which run the length of each settlement.

Voices from Afar

CONSTRUCTION and testing completed, the day came for opening of the service. On the fourteenth of February, shortly after nightfall, most Smith Islanders made their way on foot down Main Street in Ewell to the

community hall. In the dim light of kerosene lamps, men and boys in rubber boots and heavy clothing and women in shawls awaited, perhaps a little skeptically, the events of the evening. On an improvised stage a pair of telephone men put finishing touches to the installation of a telephone and loudspeaker. The gathering showed polite interest throughout an explanation of the new system; all attention stiffened as the wife of the island's clergyman took her place by the telephone on the stage. A moment later the greetings of Maryland's Chief Executive, speaking from the State Capitol, sounded through the hall.

Those ceremonial congratulations completed, she placed another call, and nodding heads and smiles revealed excited pleasure as the voice of Captain Whitelock—skipper of the mailboat—poured clearly and familiarly from the amplifier: "It's a great thing the telephone people have done for us folks." All knew the Captain's words came from a hospital bed in Baltimore, but few could comprehend how—through aerial, submarine, and underground cable, overland and under the Chesapeake Bay to Crisfield, then out through the air across the water—his voice flashed into the meeting hall. Captain Whitelock has for many years piloted messages into Smith Island ports through the slow channels of the Bay, and it was fitting that he should be among the first to use this new channel of the air to bring his message to those he has served so faithfully.

The following day, with telephone and loudspeaker, Bell System men sailed up to the peaceful boat landing at Tangier, Va., and went to the town hall there to install their equipment. In the early hours of the evening a group of nearly 400 interested people gathered to witness the ceremonies attendant upon the opening of telephone service to the mainland. Although everyone was interested in the explanation of the new telephone system and how it could be used, that interest was intensified when the minister of the island placed a call to the Governor of Virginia, in Richmond. Clearly they all heard the greetings from the Executive Mansion.

To the District Manager of the Chesapeake and Potomac Telephone Company at Salisbury, Md., came recently a letter which was signed by the Mayor, the Treasurer, and the Clerk of the Town of Tangier, Va. In it these gentlemen said, in part:

> "Inquiries come to us from time to time concerning the telephone and its service to the Island. After three months we can truly say its convenience, efficiency, and satisfaction in service are daily being increasingly realized.
>
> "Shakespeare said, 'Some are born great, some achieve greatness and some have it thrust upon them.' Concerning Tangier and the telephone, even before it is needed for emergency service, there is a sense of comparative greatness about it that means progress. . . ."

So science, and the skill and the enterprise of many people—executives and engineers, business men and boat men, installers and others—have lifted the voices of these lonely people out of dependence upon the slow channels of the water and into the swift channels of the air.

EVOLUTION BY DESIGN

The Purposes and Methods of the Bell Telephone Laboratories Are Exemplified in the Continuing Program of Development of Three Plant Items: Drop Wire, Relays, and Receivers

By REGINALD L. JONES

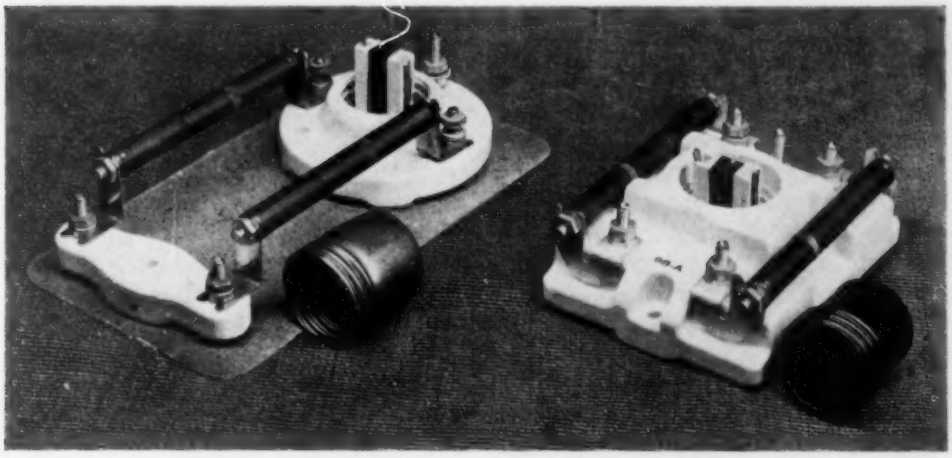
To the telephone subscriber, the "drop wire" which is suspended between his house and the telephone pole line may seem to be of quite ordinary nature. If he should examine it, he would find it to be oval in cross-section, about one-fourth inch in its greater dimension, and to consist merely of two conductors symmetrically imbedded in rubber insulation covered by impregnated cotton braid. The plant man, however, knowing by long experience the many hazards to which drop wire is subjected, recognizes it as a highly specialized product, developed by the Bell Telephone Laboratories with painstaking care to fit its particular purpose.

Of all the parts of the exchange telephone plant, the drop wire occupies the most vulnerable position. It must support itself in the gap between building and pole line, of either cable or open wire, no matter whether the distance be long or short. In many cases, it must pass through trees or other obstructions which may rub against it and finally wear it through. Damaged insulation admits moisture, which corrodes the conductor, thus gradually reducing its strength, and which also causes the subscriber's line to become noisy or perhaps to fail altogether. Because of the addition of new subscribers, changes in residence of old subscribers, and service changes, about four hundred million feet of new drop wire are needed by the Bell System each year. Obviously, low cost is an important requirement.

The Evolution of Drop Wire

The use of drop wire is almost as old as the telephone art itself. Work toward improving its performance has been carried on since the earliest days; but the major improvements have been made during the past fifteen or twenty years, as a result of general advances in chemical and metallurgical processes.

Let us pick up the development about the year 1928. By this time it had become evident, from analyses of field results and by Laboratories tests of the product, that a major source of trouble with the then standard wire was failure of the insulation at the pole and building attachments, between which the wire was suspended.



PROTECTIVE APPARATUS AT SUBSCRIBERS' PREMISES

Near the point where the drop wire enters a building, a protective device is installed to discharge harmlessly any stray current of excess voltage which might accidentally be on the outside telephone wires. The new one-piece porcelain protector at the right is cheaper to make and is better adapted for mounting in homes of modern construction than is the protector of older design

It was known that this was due primarily to the fact that as the rubber aged, it gradually lost part of its elasticity and strength and finally became brittle. Development work was undertaken with two objectives: to design a suspension attachment which would distribute the gripping pressure of the attachments over a wider area of the rubber, and to obtain a rubber having better physical characteristics.

Up to that time, the suspension device had consisted of a porcelain knob attached to a bracket, the wire being looped around the knob and secured by a tie wire. A clamping device was developed in which the wire was laid in a slot with a tapered wedge in such a way that the harder the pull on the wire, the tighter became the gripping action of the wedge. This wedge-type clamp, because of its relatively large gripping area, reduced the unit pressure on the insulation to a satisfactory level. Basically, it is the drop wire clamp in use today, although a number of design improvements have been made since it was first devised.

"Rubber" insulation such as is used on drop wire is a complicated compound of which rubber itself is only one of the constituents. The compound includes sulphur, "mineral rubber," which is an air-blown asphaltic compound, and "mineral fillers" such as whiting and zinc oxide; it also contains organic materials known as antioxidants (to retard aging) and accelerators (to hasten vulcanization). The Laboratories technicians to whom fell the job of securing a better rubber were faced with the essential problem of finding the particular mixture of ingredients which would best meet the requirements of drop wire insulation.

It soon became evident that, as a first step, it would be necessary to

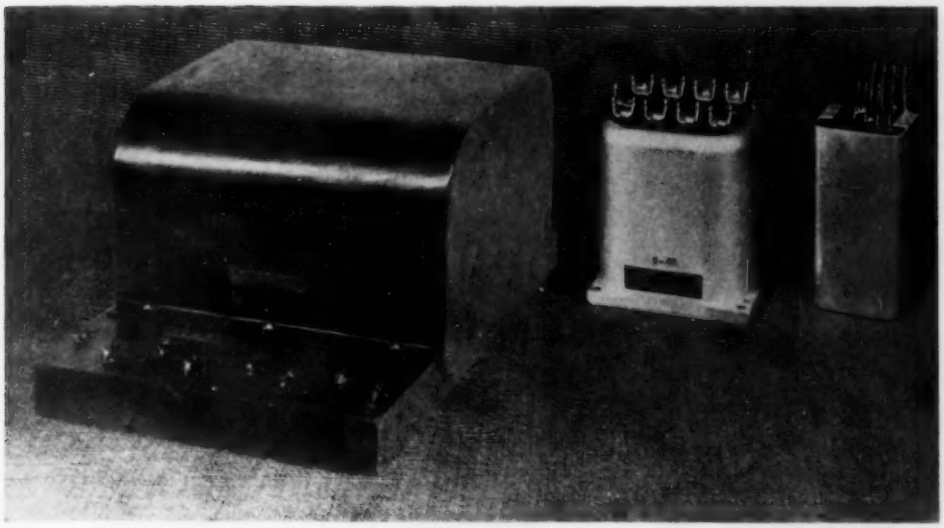
devise improved testing techniques for evaluating the relative worths of various mixtures. To replace the tensile strength testing apparatus then available, the Laboratories engineers developed a device for determining the compressive strength of rubber as insulating cover on a conductor. At about the same time, there became available a device known as an "oxygen bomb," in which samples of drop wire insulation could be artificially aged by exposure to oxygen at high pressure and elevated temperature. With these new test tools, and with a large previously acquired knowledge of rubber characteristics, the engineers prepared and tested many kinds of rubber compound. After several years of laboratory work, an insulation was evolved which was much superior to the old from the standpoints of crushing and aging.

DURING this same interval, the Western Electric Company, in cooperation with Bell Laboratories engineers, developed a new technique for manufacturing drop wire, by means of which the insulation was extruded around the conductors in unvulcanized form and then vulcanized in one continuous operation. This replaced the former method of extruding unvulcanized wire into pans of talc or soapstone and then vulcanizing in the pan. The new manufacturing process was simpler and less expensive than the old; but, together with the better rubber compound, it accentuated a problem which, while troublesome with the older form of wire, had been partly masked by other deficiencies. This problem was the tightness with which the rubber adhered to the conductors.

A good bond between rubber and conductor is essential in order to prevent the conductor from slipping through the insulation at a point of clamping, thus causing the rubber and surrounding braid to take more than their share of the strain, and to break. In the older wire, the bronze conductor was tin coated, primarily to prevent corrosive reaction between the sulphur of the rubber and the copper constituent of the bronze. The adhesion between tin and rubber was strong when the wire was new, but decreased rapidly with age. The Laboratories engineers found that by placing a thin layer of brass, of a closely controlled copper-zinc composition, next to the rubber, good adhesion was secured not only when the wire was new but during service. However, it would not have been satisfactory to deposit the brass directly on the bronze conductor, due to the resulting diffusion of the zinc into the bronze. To overcome this difficulty, and at the same time to afford corrosion protection, a coating of lead alloy was placed over the bronze conductor before the brass coating was applied.

During this same period, the bronze conductor itself received development attention. A new bronze was evolved, containing a larger amount of tin than the older bronze. This bronze was stronger, permitted the size of the conductor to be reduced, and at the same time met the electrical conductivity requirements for drop wire.

THE cotton braid covering of drop wire is needed to protect the wire from abrasion, and from sunlight, which would tend to cause cracking of the rubber. To improve its dura-



STEPS IN THE DEVELOPMENT OF "INPUT" TRANSFORMERS

They form part of the repeaters used to amplify the currents at regularly spaced intervals along telephone toll lines. At the left is the transformer associated with an early type of repeater. The widely used transformer in the center has been superseded recently by the smaller one at the right, which requires less space and is improved electrically

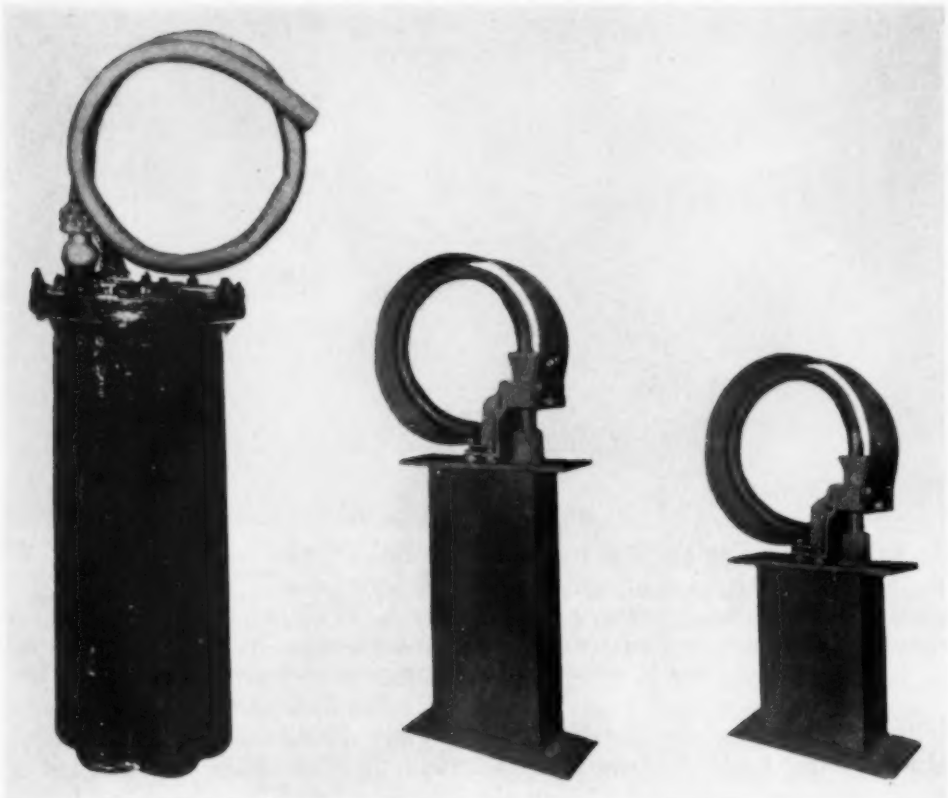
bility and increase the abrasion resistance, the braid is treated with weatherproofing compound. Many of these compounds have been studied. The present treatment involves saturating the braid with a mixture of selected asphalts and waxes, followed by a coating of stearine pitch and, finally, by a coating of ground mica.

The decrease in conductor diameter has made it practicable to use a heavier cotton braid and a correspondingly greater amount of weatherproofing compound than in the older wire, thus further increasing durability and abrasion resistance and at the same time retaining the former cross-sectional size. Retention of size makes it possible for the plant man to use the same "braid stripper" for both new and old wire, avoiding duplication of installation tools.

Thus, during the period from about 1928 to 1938, there was evolved a drop wire which has longer life, better adhesion, and higher abrasion resistance, but costs no more than the wire it replaces. The Laboratories, nevertheless, at outdoor test stations located at San Antonio, at Miami, at Chester, New Jersey, and at the New York headquarters, continue their search for a still better product.

Organized Development Effort

THE development of drop wire is typical of the Laboratories method, in that it utilized and integrated the creative efforts of a number of technicians in various fields of research and engineering. The telephone plant as a whole, with its manifold, interlocking parts, requires a large and highly specialized personnel and ex-

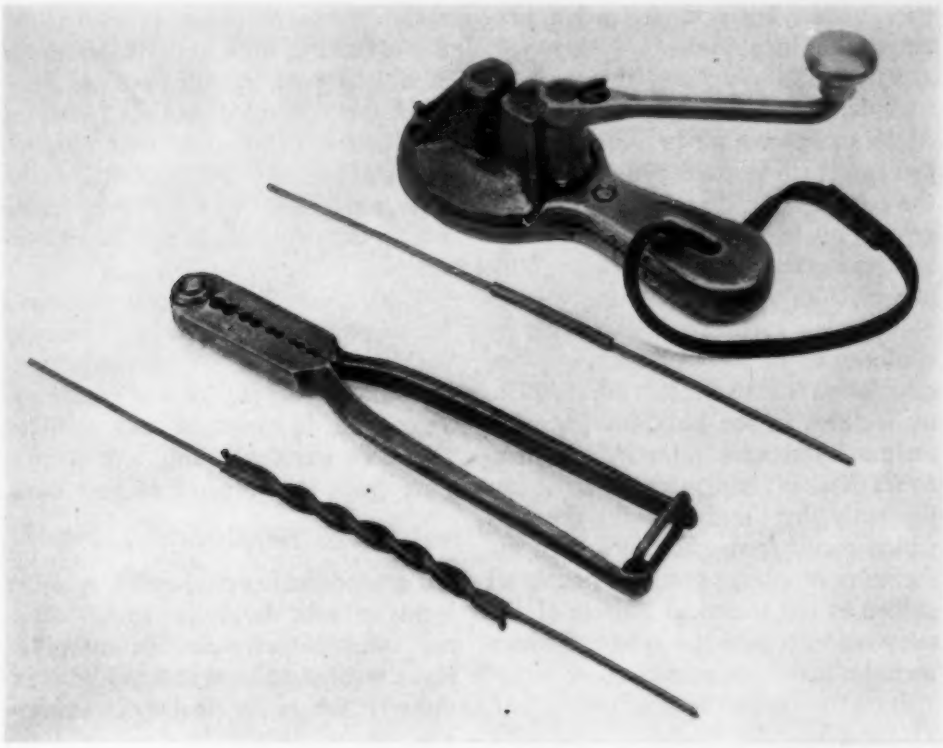


LOADING COIL CASES

Each case contains 200 loading coils; each coil consists of many turns of fine wire around a ring-shaped magnetic core. Left, with iron coil cores, made available in 1926, total weight 1750 pounds. Center, with permalloy cores, made available in 1931, total weight 455 pounds. Right, with molybdenum-permalloy cores, made available in 1937, total weight 360 pounds. Loading coils are placed at intervals along a telephone line when it is desired to improve the efficiency of the circuits by "loading." The cases shown here are for use with exchange cable; other types for use on both exchange and toll lines have been similarly improved

tensive facilities to meet its needs for coincident developments. To carry on the necessary work, the Bell Telephone Laboratories employ about 2,000 scientists and engineers; 1,000 draftsmen, laboratory assistants, skilled mechanics, and artisans; and a total personnel of over 4,800.

The Laboratories' headquarters are in New York, in a ten story building occupying an entire city block and containing the multitude of individual laboratories, machine shops, drafting rooms, and paraphernalia necessary for the functioning of an organization of this kind. In addition, auxiliary laboratories for special purposes are located at a number of points in New Jersey, and include an outside plant laboratory at Chester, radio laboratories at Whippany and Holmdel and Deal, and a chemical laboratory



JOINTS IN OPEN-WIRE TELEPHONE LINES

Below are a twisted-sleeve joint and one of the pair of sleeve-twisters used to make it. Before twisting, the sleeve is in the form of straight twin tubes slightly larger than the wire in diameter. Above are the more recently developed rolled-sleeve joint and the rolling tool. The wires are inserted in opposite ends of the sleeve, and the tool is applied at one end of the sleeve and rolled along to the other end by turning the handle. Applying pressure of about one ton, this process reduces the diameter of the sleeve to a tight grip on the wire, as strong as the wire itself and free from corrosion difficulties

at Summit. These are used for development projects which require large amounts of space or special test conditions not available in New York City—as for instance, a study of the effect of wind on open wire lines.

THE technical forces of the Laboratories are organized in three general departments: Systems, Apparatus, and Research. The Systems Development Department formulates circuits and assemblies to serve both switching and transmission needs of the Bell System plant, and prepares switchboard and central office equipment specifications for manufacture and installation. The Apparatus Development Department designs and specifies most of the items of apparatus and material used at subscribers' stations, in central offices, and in the outside plant. The Research Department conducts fundamental studies in physics and chemistry, emphasizing particularly the branches of sci-

ence underlying communication phenomena and materials.

By careful planning, the work of each department is coördinated within itself and with that of other departments. An important phase of this is the continuous dissemination, to each group, of knowledge concerning the new materials, processes, apparatus, and circuits which are being worked on by other groups. This is done by conferences of key engineers, by the circulation of technical memoranda, by lectures in the Laboratories auditorium, by articles in the *Bell Laboratories Record,* and, perhaps most importantly, by the day-to-day contacts which result from the centralized association of a large group of people all skilled in the technical aspects of the telephone art and the sciences which underlie it.

A CASE in point is the development for telephone use of certain oxide mixtures which have the characteristic that their resistance to electric current decreases rapidly with increase in temperature. Basic laboratory studies led to the conclusion that such mixtures could be usefully employed to meet several immediate needs of the telephone art and that probably they could be adapted advantageously to other needs.

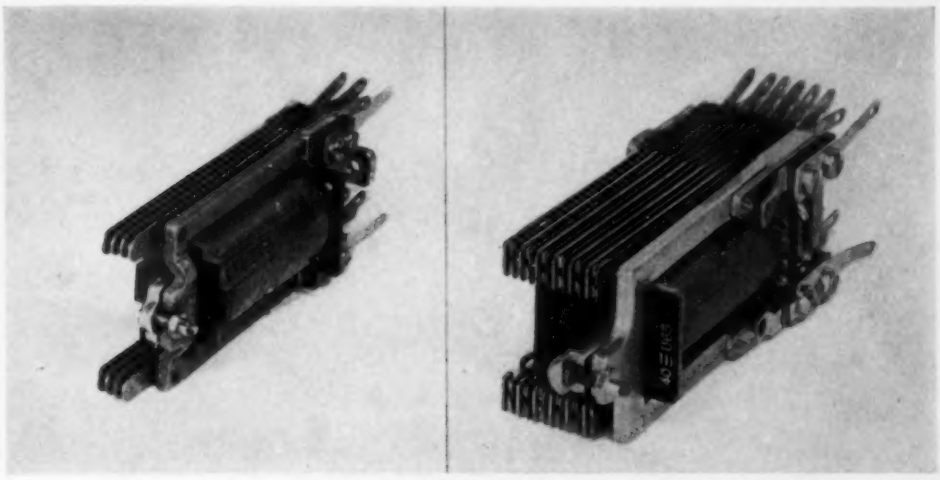
By means of lectures held in the Laboratories auditorium, the technical staff was made familiar with the theoretical possibilities of the mixtures and the applications in prospect up to that point. A new tool, the "thermistor," thus became a part of the working capital of the Laboratories engineer. Within a short time, thermistors were being developed for such diverse purposes as controlling the operation of a supervisory relay in a toll trunk circuit, keeping constant the amount of output power of a cable carrier repeater with changes in input power, and stabilizing the transmission loss of a telephone cable circuit with changes in cable temperature.

With these Bell System resources for laboratory study, analysis, and experiment in mind, let us further examine in broad outline the recent development histories of two familiar telephone parts which, like drop wire, have been in use since earliest days.

The Telephone Relay

IN a telephone central office, whether local or toll, large or small, there are many contrivances for establishing the connections and guiding the voice currents to their destination. Each has reached its present form as a result of a large amount of development effort. We shall focus our attention on one: the relay, which is the automatic switching device of the telephone network. About ninety million relays are in use in the Bell System. In some types of dial system, as many as five hundred relays may come into play in completing a connection between two subscribers, and ten or more of these relays may remain in action until the subscribers hang up. Many relays are called upon to operate millions of times during their service lives. Reliability of performance, small size, and low cost are paramount design objectives.

The basic relay parts are an electromagnet and a switch operated by this magnet. The magnet is made of a wire-wound iron core and a movable



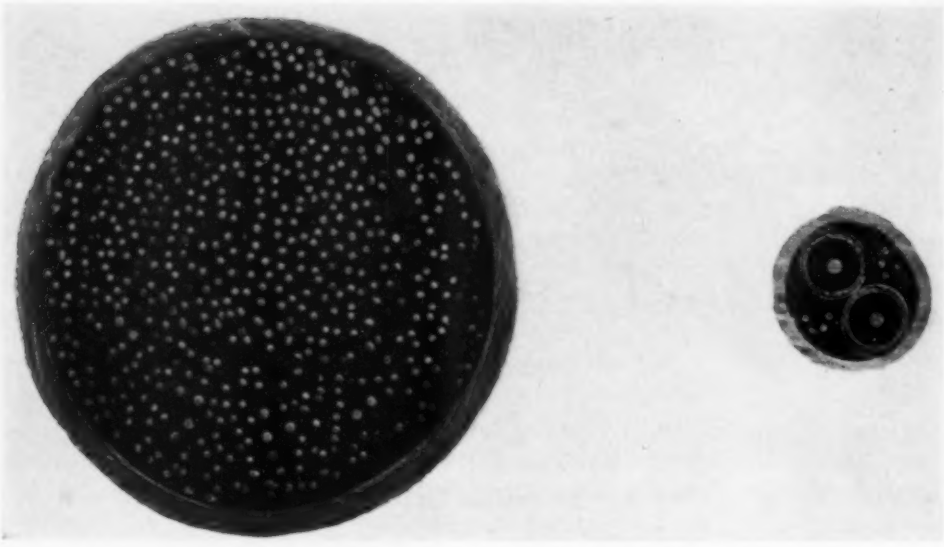
TELEPHONE RELAYS

The most recently developed type of relay, at the right, is more powerful than the older type shown at the left, will operate a larger number of contact springs, and embodies other improvements in design, as discussed in the accompanying text

iron piece called the armature. The winding is arranged for connection to a control, such as an operator's key, the dial of a telephone set, or another relay. The armature is usually hinged at one end, with its other end free to move toward the core in response to the magnetic force generated by a current in the winding. The armature, in turn, operates the switch which, in most relays, consists of a number of reed-like contact springs mechanically coupled to the armature and moved by it to make or break the desired electrical circuits. Each spring is about one-fourth inch wide and two inches long, and has a small contact point welded near one end. The distance over which a spring moves is about one-sixteenth inch.

THE wire of the magnet spool is coated with enamel or silk; but still more insulation is needed for such purposes as separating the winding from the core, spacing the terminal wires from the rest of the winding, and affording mechanical protection. For these purposes, early designs of relay employed materials such as bookbinder's cloth and ordinary paper similar to writing paper. A source of trouble with relays has been gradual corrosion of the wire, which finally causes the winding to open. Intensive laboratory study indicated that this corrosion was due chiefly to impurities in the insulating materials. One by one these impurities have been eliminated by the development of insulating materials better suited to the purpose. The most recent step in this phase of relay development has been the substitution of thin sheets of cellulose acetate for the paper insulation of former times.

In order to retard corrosion, the paper insulation of the older relays was impregnated with wax. Particles of the wax, seeping from the winding,



TWO TYPES OF MODERN TELEPHONE CABLE

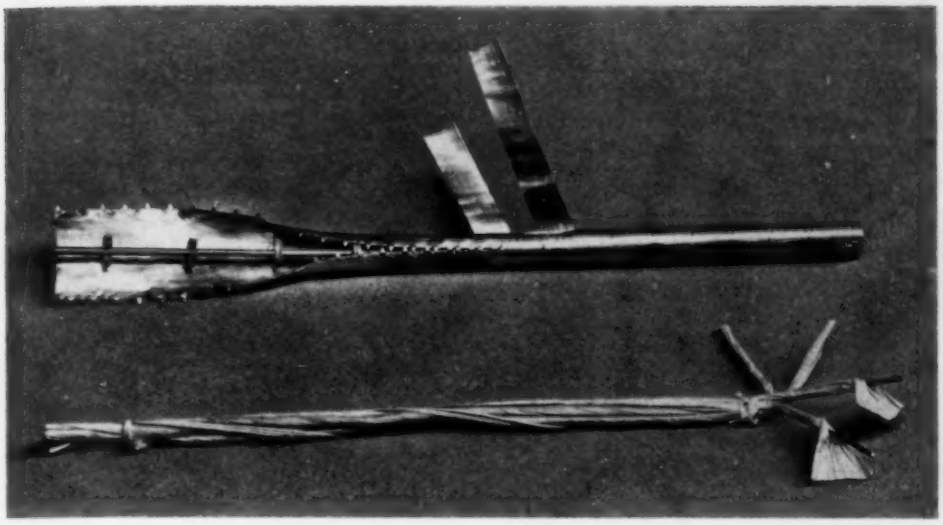
A quadded toll cable, left, and one form of the recently developed coaxial cable, shown in cross section, about actual size. The quadded cable contains approximately 150 "quads" of paper-insulated wires. The coaxial cable contains two copper conductors, each held centrally in a copper tube surrounded by helically-wound steel tape, and also two quads for circuit supervisory purposes. Both cables have about the same message capacity. Structural details are shown on the opposite page

would in some cases be deposited on the moving parts of the relay, causing the armature to stick. With cellulose acetate insulation, wax treatment was discontinued, and sticking became a less serious problem.

Insulation made of cellulose acetate has an additional advantage: it is better adapted than paper to manufacturing processes using automatic coil winding machinery. The new insulating material has made practicable several major advances in manufacturing technique, and these have reduced the cost and improved the uniformity of the product.

THE most vital part of the relay, and at the same time one of the most vulnerable, is the tiny projecting contact welded to the contact spring. The shape of this contact and the metal of which it is made are of great importance in determining the relay's reliability, and have been the subject of almost continuous laboratory study. Extensive investigations have been made of the behavior of contacts of various metals and shapes when subjected to mechanical action and to erosion of an electric spark, the amount and effect of tarnish, the pressure required for good contact, and the effect of foreign particles.

Silver, tungsten, platinum, rhodium, iridium, gold, and palladium, and their alloys, all find use as relay contacts. Years of experience have shown that precious metals are better than base metals for contact purposes. For



COMPONENTS OF CABLES

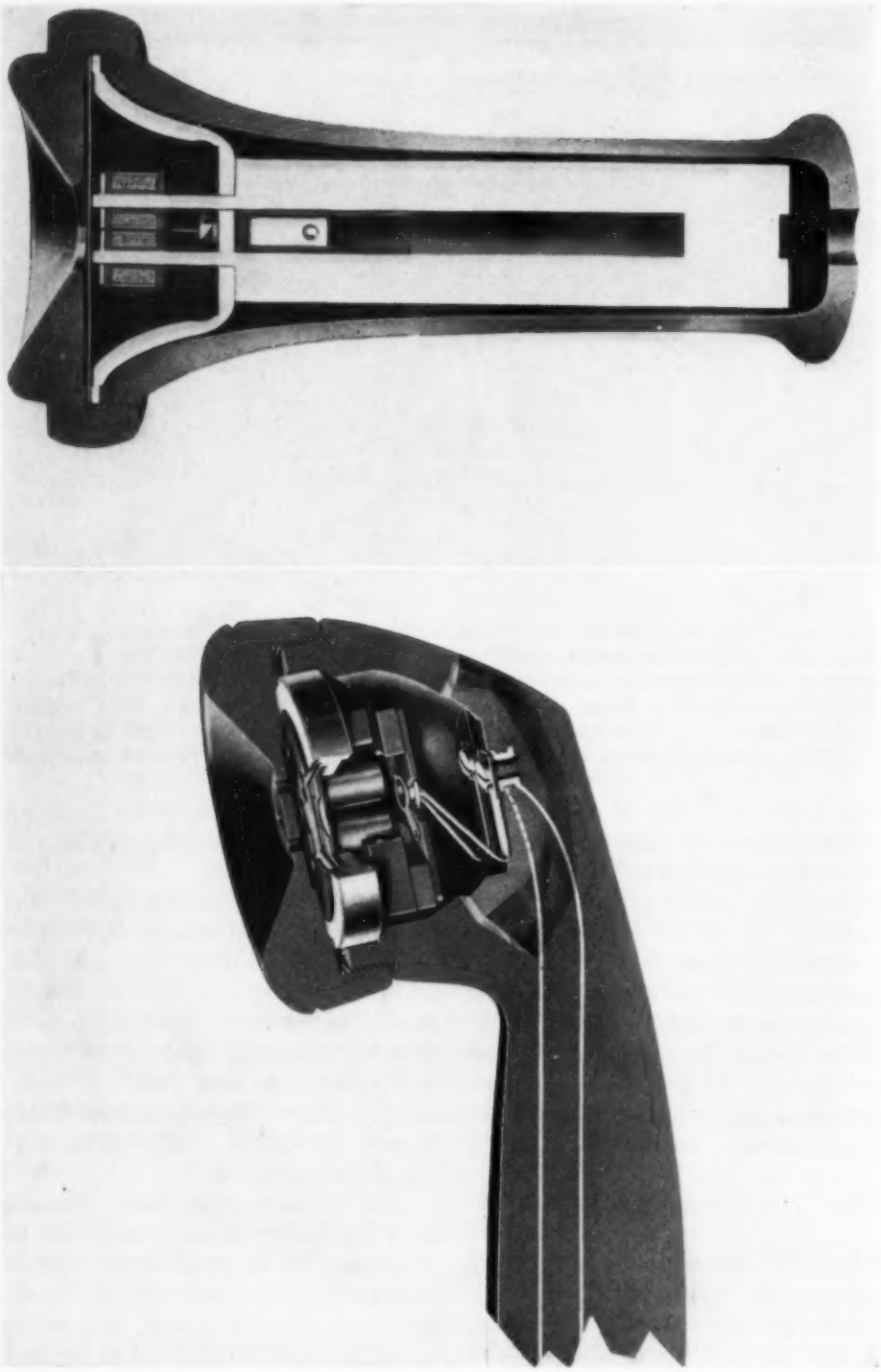
At the top is shown one of the two coaxial conductors pictured in the cable at the right on the opposite page. The central wire is held in place by insulating discs and enclosed in a copper tube which is wound about by two steel tapes, and is enclosed, with its twin and two sets of quads, in a lead sheath. Below is a quad, composed of four copper wires, each wrapped in paper insulation and then twisted together. Coaxial cable is cheaper per mile to make than the quadded cable shown opposite, but requires more expensive terminal equipment

many kinds of relay, silver or palladium is the most satisfactory. As regards shape, the older contact, with its pin-head contour, has been replaced by one in the form of a tiny bar about one-sixteenth inch long and one-sixtyfourth inch high. The bar of one spring is mounted horizontally and the bar of its companion spring vertically, so that the two contacts, when touching each other, are in the form of a cross.

FOREIGN particles have been a frequent source of relay trouble. The air is full of minute objects: drops of moisture, bits of hair, soot and coal, metallic particles, fibers of cotton, silk, and wool. With the thousands of relays in a central office, it is not surprising that at times one of these floating particles should lodge on a contact surface and prevent proper closing of the contacts.

To diminish troubles from this source, individual covers have been used to keep the dust away, the contacts have been mounted in vertical planes to minimize accumulation of dust by settling, and air filtering equipment has been used in some cases. A recent improvement which is very effective is a relay spring having double contacts.

The advantage of twin contacts over the former single contact can be illustrated by an extreme example of atmosphere wherein dust particles are so dense that at every thousandth operation a contact, when pressed against its mate, will close over a piece of dust or lint, and thus fail to



. TELEPHONE RECEIVERS

The desk-stand receiver, above, has been largely superseded by the hand-set receiver below. Differences between them are described in the text on the opposite page

operate. If now the contact on each spring is split into two independent members, the chance of a particle falling between the second set of contacts will also be one in a thousand; but the likelihood of two particles of dust falling at the same time, one between each of the sets of contacts, will be one-thousandth as large, or one in a million. Field experience has indicated that with the twin contact arrangement, as used in practice where the two contacts are not independent, the improvement in reliability of operation is about ten-fold.

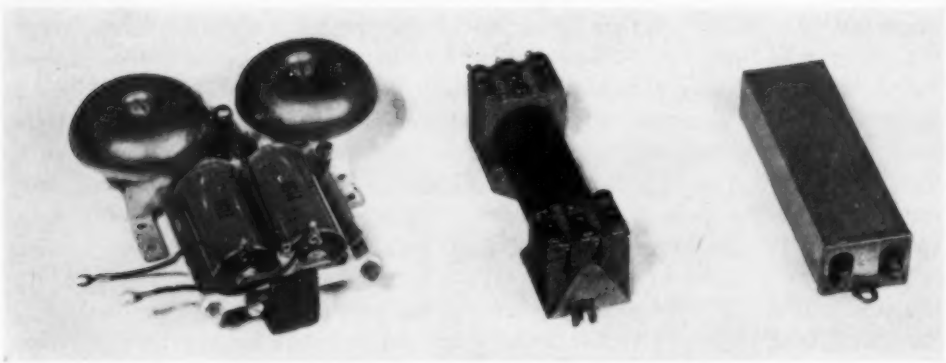
RELAY springs must be properly dimensioned and mounted. Otherwise, when they close they may bounce apart and flutter back and forth for a few thousandths of a second. The consequent "chattering" of the contacts results in excessive contact wear, and may cause false switching operations. Studies of spring shape and mounting have been an important phase of Laboratories' design. As part of this work, high speed motion picture apparatus developed by the Laboratories has been utilized to photograph in "slow motion" the rapidly moving relay parts.

Another objective in development studies has been the improvement of the electrical and mechanical efficiencies of the relay so that a smaller operating current is required and the load on the central office battery is reduced. In recent years, this phase of the work has received added emphasis as the number of circuits controlled by a relay has increased, due to advances that have been made in automatic switching systems. In relays of more recent design, the cores of the windings are somewhat larger, the shape and material of the magnet are altered, and the armature hinge is improved, in order to increase the pulling power. By these means, sufficient power has been added not only to permit the use of more springs but to increase the pressure per spring and also the distance over which the armature and springs move. The greater pressure has served to increase the reliability of operation. The greater swing provides surplus movement which is utilized to take up wear on the contacts and so to increase service life.

Thus the development of the telephone relay goes forward: contact materials and shapes, elimination of chatter, protection from dust and dirt, improved magnetic structures, better windings—all are being studied by the Laboratories in the constant effort to provide more efficient and trouble-free telephone apparatus.

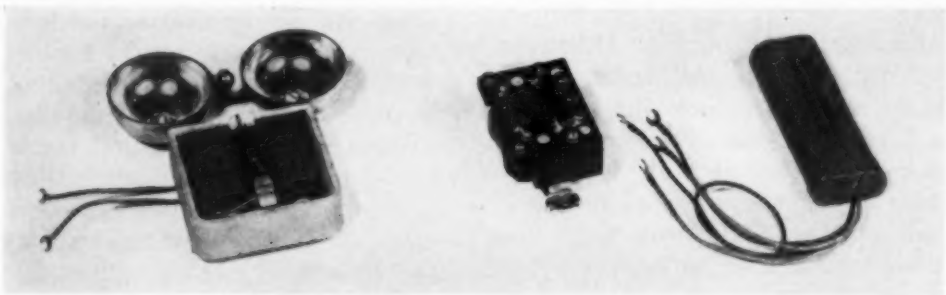
The Telephone Receiver

IN Bell's original telephone, the sound waves of the voice caused a piece of magnetic material to vibrate in the field of an electromagnet, and thus to generate in the coil of the magnet a varying current. At the receiving end of the circuit, this current passed through a similar coil and caused another piece of magnetic material to vibrate, reproducing the original sound waves. In the earliest commercial telephone receivers, the electromagnet was replaced by a permanent magnet, the coil was placed around an iron pole-piece attached to the end of the permanent magnet, and the vibrating piece of magnetic material was a disc of iron.



APPARATUS IN THE TELEPHONE SET

Above are the ringer, induction coil, and condenser used in a telephone of older design. Below are the improved ringer, induction coil, and condenser for the latest type of telephone



This same general arrangement for converting electrical energy into sound energy has continued in use throughout the development of the telephone, and is found today in the many millions of telephone receivers in service in this country and throughout the world. However, although the operating principle has not changed, many improvements in receiver design have been made as the years have gone by. Up to about 1927, these improvements were of such nature as not to alter radically the instrument's general external appearance. The hang-up receiver of the desk stand of that time bore a resemblance to the receiver of earlier days, although it was ten times as efficient. With the advent of the hand set, in which the transmitter and receiver are mounted as a handle-like unit, both the appearance and the internal design were radically changed.

The extent of the change in internal design is indicated by the fact that the receiver unit of the hand set weighs only about three ounces, as compared with ten for the unit of the desk stand.

Until about four years ago, the telephone receiver was so designed that its diaphragm was clamped rigidly around its edge by the receiver cap. This arrangement produced a vibrating element which was most efficient at its natural period of vibration.

The thickness and diameter of the diaphragm were so proportioned as to place the maximum efficiency at about 1,000 cycles per second (two octaves above middle C on the piano). This placed the greatest response of the receiver at a tonal pitch in the middle of the voice range. While emphasis on sounds in this range was helpful in producing loudness, the naturalness of voice reproduction was of course somewhat impaired.

IN the meantime, receivers and loud speakers for high-quality speech reproduction, such as those of public address and broadcasting systems, had been developed by the Laboratories to a point where they operated with satisfactory loudness without diaphragm vibration at its natural frequency. The designs were relatively complicated, however, and extensive development work was required to adapt the principles involved to the small receiver unit of a telephone set. The more important features of these high quality systems were incorporated in a Bell System hand set placed in production about 1937.

In the improved receiver, the permanent magnet is made of an alloy of cobalt, molybdenum, and iron, instead of the former cobalt-iron alloy; the pole-pieces are of permalloy instead of silicon steel; and the diaphragm is made of permendur instead of magnetic iron. By proper design of the dimensions of the air spaces in front of the diaphragm and behind it, and of the openings connecting these spaces with the ear and with the housing of the receiver, and by using better magnetic materials, with a consequent increase in efficiency, it has been practicable to obtain a naturalness of speech reproduction far beyond that of previous receivers and with no material decrease in loudness.

Thus, the telephone receiver, relying for its operation on the same basic principle conceived by Alexander Graham Bell, has over the course of the years been greatly improved in efficiency and in quality of sound reproduction, and at the same time has been reduced in size and weight.

THESE development histories are illustrative of the manner in which Bell Telephone Laboratories perform their function of designing telephone equipment to meet Bell System needs. Drawing upon field experience and ideas, as reported to them by the American Telephone and Telegraph Company and the associated telephone companies, and upon observations and ideas of their own specialized technicians, the Laboratories constantly survey each over-all operating mechanism and each component part, no matter how small, and continuously bring into being new and improved kinds of apparatus for telephony and its related arts of electrical communication.

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By FRED C. BAURENFEIND

She responds to your call with a pleasant "Information"—to your call and to three million others which are handled daily by over ten thousand employees engaged in furnishing Information service throughout the Bell System. If you live in a small community, perhaps you recognize her voice, for frequently she alone is responsible for handling the calls which reach Information. In the larger cities, she may be one of as many as five hundred operators required every day to give this service. In either case, she takes her responsibilities seriously, and is anxious to serve to the best of her ability those who consult her. She is interested in her job, for in it there is variety—a variety of calls and requests which keep her abreast of the happenings in her community.

There is the housewife who likes to shop by telephone, for instance, and wants the telephone number of the new grocery store on the corner; the young lady, home from school, who wants to telephone for an appointment with a certain hairdresser recommended by her roommate but whose number she has been unable to find in her directory; the young man who is trying to locate the telephone number of that good-looking girl he met at a party the night before. There are calls for the telephone numbers of hotels, airports, and railroad terminals from visitors in town; calls for the telephone numbers of prominent people; the urgent request for an ambulance, or the call from a youngster who is in some difficulty and asks the assistance of Information in obtaining the telephone number of the family doctor. There are requests for telephone numbers from salesmen, professional men, and business executives who find the services of the Information operator invaluable in their day-to-day telephone communications with their customers and associates.

Then, of course, there is always the unusual situation in which the operator's experience and good judgment play an important part—as, for example, the cleaning matron who finds herself locked in the building and wants to know how to get out. Another customer wants to know the telephone number of some one in the dead flower business (he means artificial flowers), another wants advice on

some domestic problem. There is also the appeal from the elderly person who is ill and unable to take Buster, her dog, for his usual walk in the park. Can the operator suggest anything? Fortunately, yes, for a search of her records reveals the existence of a "dog walking service," the telephone number of which is suggested to the calling customer—and Buster once again is happy and well taken care of.

While the Information operator obviously cannot supply the answers to all questions which are asked of her, she is usually able to do so better than nine times out of ten and, on the average, in about half a minute. Considering the fact that she frequently has but very meager details with which to search her records, that on about one-fourth of the calls she handles customers are unable to supply a definite name to associate with the telephone number desired, that there are unusual situations which must be coped with, and that there are still a great many people who do not have telephones, it is not difficult to account for that tenth time when she is unable to be of assistance or must admit of a limit to her fund of information.

In the Early Days

IN the early days of the telephone, calls were placed by name instead of by number. While telephone directories were published as early as 1878, they were merely lists of subscribers to the service and, except as they perhaps encouraged the use of the telephone and stimulated a demand for the service, they had no directional telephone value. The handling of telephone calls by name was a very personal service, but as the number of telephones in service increased in the larger towns and cities, the abandonment of this practice was inevitable. Telephone growth, however, was not the only reason for changing to number designations. Evidence of another consideration is expressed in the following excerpt from a paper on "The Telephone System of Today" which was presented in Boston on November 24, 1903, at a meeting of The Insurance Society of New York:

"When the telephone central stations were first established, the names and positions on the switchboard of the subscribers were known to operators with strong memories; an epidemic of measles occurred in Lowell, Massachusetts, and Dr. Moses Greeley Parker, a member of the Board of Directors, viewed with alarm, from his standpoint as a physician, the possible condition of affairs if more than two of the four operators should be taken with the measles, and proposed that the subscribers should be numbered.

"His associates demurred, as they were of the opinion that the subscribers would give up their telephones sooner than submit to the indignity of being known by number, but in view of the contingency of the service being paralyzed they finally yielded, and to the surprise of all, the new arrangement was cheerfully accepted by the subscribers, who appreciated the improvement in service which resulted from the change."

WITH the introduction of number designations, telephone directories of course began to show customers' numbers. When local operators were relieved of the responsibility of remem-

A MODERN INFORMATION BUREAU EQUIPPED WITH FREQUENTLY REPRINTED RECORDS

Pictured here is one of the largest information bureaus of this type in the Bell System. The arrangement of operators' positions, the accessibility of records, and the privacy afforded individual operators conduce to the furnishing of an Information service which is pleasing to customers

bering the names of all their customers, and their locations on the switchboard, they were able to concentrate on the numbers of new customers whose telephones were connected between directory issues, and usually were able to supply these numbers from memory. As the business continued to grow, however, this added responsibility became too much for the local operator, and finally the Information specialist came into being.

From its early beginnings, the provision of Information service has been the subject of the study and development which are characteristic of the Bell System's approach to the task of rendering a pleasing and efficient service to its customers. Staff engineers at the System's headquarters in New York, as well as the men and women in the operating telephone companies who are directly concerned with the conducting of the business day by day, have constantly under review the various phases of this important specialized service—the training of Information operators, the design of equipment, the adequacy of records, and other aspects of the job—so that it shall contribute its share to a telephone service which is not only the

best in the world but shall continue to be the best that it is possible to render.

Information Records

THERE are, as a consequence, several types of Information records in use throughout the System today, each one designed to fit the needs of the particular locality in which it is used. In the smaller exchanges, Information records may consist of a customers' directory and a long-hand list of new telephones connected after that directory went to press. Many refinements have been incorporated in the arrangement of these basic records for use by Information operators in such localities. In the larger cities, however, either frequently reprinted book records or rotary file records are the types more commonly used. The former is a book record of telephone listings which, as its name implies, is reprinted at frequent intervals, while the latter is a record maintained in a specially designed circular file.

Customers' listings in Information records may be arranged in two different ways. The first is an alphabetical arrangement, in which customers are listed in the same manner as in the telephone directory. The second is a street address arrangement, in which the listings appear numerically under the proper street name. If there are two or more listings at the same address, these are shown in their proper alphabetical order.

All Information Bureaus are equipped with alphabetical records, and in many of the larger cities both alphabetical and street address records are provided. Under certain conditions, the provision of street address as well as alphabetical records makes it possible for the operator to conduct a more rapid search for the number requested than she could if only the latter were available. This is particularly true on calls involving common names. In one of the larger cities, for example, there are 15 columns of "Smith" in the telephone directory. On a call for the telephone number of a person by that name at a given address, it is obvious that a search of the alphabetical record is apt to be a lengthy one unless the person calling knows the first name or initials, while the search of the street address record probably would reveal more quickly the number desired. Also, on calls involving an indefinite name, or when the name is unknown but the person calling knows the business and address of the person whose telephone number is wanted, the street address record enables the operator to conduct an effective search for the number which otherwise might not be possible.

IN cities using frequently reprinted book records, both the alphabetical and street address records are brought up to date and reprinted at frequent intervals. Between printing intervals, the alphabetical record is supplemented with a printed alphabetical list known as the "daily addendum." This list is placed on the Information switchboard early each morning, and contains all the new and changed listings which have occurred from the time the alphabetical record went to press up to the close of business the previous day. In some cities, where experience has indicated the need for even more up-to-date information,

ROTARY RECORDS ARE USED IN THIS MODERN INFORMATION BUREAU

The staggered positions of the desks, and the floor racks between pairs of girls, make all records readily available to each operator in this moderate-sized Information bureau

"new telephone" files are maintained from current connections, so that if a calling person indicates the telephone number desired is one connected "this morning," the operator is usually able to obtain it for him.

Prior to the introduction of frequently reprinted records, in some cities the alphabetical record used by Information was the regular customer directory, which was supplemented by a bi-weekly alphabetical addendum and a daily alphabetical addendum. The street address record was supplemented in some cases by a bi-weekly address addendum, but was reprinted only as frequently as the customer directory. This arrangement of records adversely affected the time interval involved in locating telephone listings, because operators frequently found it necessary to consult one or more of their addenda records to obtain the information desired. This was particularly true with increasing obsolescence of the customers' directory. In one large city it was found that for every 1,000 calls handled, the operators were obliged to consult over 1,800 records under this plan, while with frequently reprinted records this number was reduced to less than 1,300.

Use of Rotary Files

ROTARY file records, both alphabetical and street address, differ from frequently reprinted records chiefly in that they are contained in rotary files instead of books, and in the method of maintenance. The rotary file consists of a stand on which rotating drums are mounted, and fastened

AN INFORMATION POSITION

The operator is using one of the frequently reprinted records provided for her individual use. In the racks are current directories for other frequently called localities, which are also within reach of operators at adjacent and opposite positions

in segments of these drums are frames which carry the listings. The stand may have one or two drums, giving either a one-tier or two-tier rotary. Rotary files are placed on the switchboard in a manner which makes them easily accessible to the operators who use them. When an order is received for the connection of a new telephone, inserts containing the new customer's listing are prepared by the clerical force at the Information center. When advice is received that the telephone has been installed, these inserts are placed in their proper positions among the other listings in each of the rotary files. When a telephone is disconnected, the inserts showing the listing of the customer involved are removed from the files.

Information Equipment

INFORMATION operators work in groups or teams, except in some of the smaller localities where one operator, or sometimes one operator who combines Information with some other type of operating, is sufficient

FREQUENTLY REPRINTED RECORDS

Note that the open directory is five columns wide. Directly above it is a ready-reference list of the local numbers most frequently requested. At the left is the key panel used in operating the position

to care for the needs of the community. The size of these teams will vary, depending upon the volume of traffic to be handled and the kind of equipment in use. From the standpoint of team arrangement, there are two types of equipment in use throughout the System at the present time.

The first and original type is arranged to provide for terminating directly on the operator's position the Information trunks from the central offices served by an Information Bureau. Associated with each trunk is a lamp signal which lights whenever that trunk has been selected on a call for Information, and the operator selects the trunk on which she wishes to answer by manually operating an answering key which is provided for each incoming trunk. This kind of equipment is generally used in the smaller Information Bureaus, where the volume of traffic does not require the use of large teams of operators. The trunks can be multipled to as many positions as are needed to handle the traffic during the busiest period of the day.

When the volume of traffic is such that more trunks are required than can be terminated on one position, two or more groups of positions and a corresponding number of teams of operators must be used. This, in effect, divides up a large information bureau into two or more small ones, and is not a desirable arrangement, particularly in the larger cities em-

ROTARY FILES IN USE

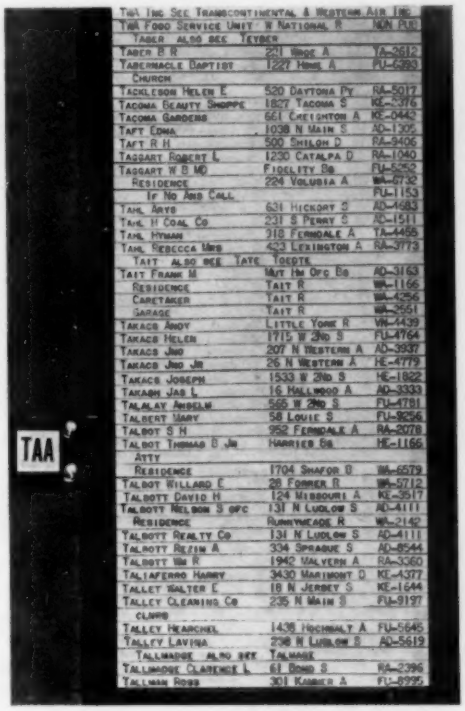
The upper tiers of the files here pictured carry the alphabetical list and the lower tiers the street-address list

ploying hundreds of Information operators, for it develops certain inefficiencies in operating and tends to affect adversely the speed of service. The introduction of call distributing, the second type of equipment developed for use in the larger cities, remedied this situation.

Call distributing equipment is arranged to distribute calls to idle operators.* With this arrangement, incoming trunks are not wired directly to operators' positions. Instead, each trunk is connected to a position-selecting switch which performs the function of associating an incoming call

* "Idle" meaning in this instance simply operators who are not engaged at the moment in actually responding to inquiries and who are therefore free to accept new ones.

with any one of a number of Information positions. Each switch is provided with terminals for use in establishing "paths" to 40 Information positions, if desired, and in response to an incoming call the switch will automatically test these terminals until it finds a path to a position at which an operator is idle, waiting for a call. When the position has been selected in this manner, the operator receives a signal indicating that there is a call on her position to be answered, and is in immediate communication with the calling customer without further action on her part. Position-selecting switches are arranged so that as many as 120 can be used for terminating incoming trunks in a single group, and the calls received over these trunks can be distributed, if necessary, to a team of 40 operators. In addition, the design of call-distributing equipment practically insures that incoming calls will receive attention at the Information Bureau in the order that they are received.


TAA
TAA Inc See Transcontinental & Western Air Inc
TAA Food Service Unit W National R NON PUB
Taber also see Teyber
Taber B R 241 Wade A YA-2612
Tabernacle Baptist 1227 Hines A FU-6390
Church
Tackleson Helen E 520 Daytona Pv RA-5017
Tacoma Beauty Shoppe 1807 Tacoma S KE-2976
Tacoma Gardens 661 Creighton A KE-0440
Taft Edna 1038 N Main S AD-1306
Taft R H 500 Shiloh D RA-9406
Taggart Robert L 1230 Catalpa D RA-1040
Taggart W B MD Fidelity Bg FU-5252
Residence 224 Volusia A WA-6732
If No Ans Call FU-1153
Tahl Aryo 631 Hickory S AD-1683
Tahl H Coal Co 231 S Perry S AD-1511
Tahl Hyman 318 FernDale A TA-4456
Tahl Rebecca Mrs 423 Lexington A RA-3773
Tait also see Tate Toedte
Tait Frank M Mut Hm Ofc Bg AD-3163
Residence Tait R WA-1166
Caretaker Tait R WA-4266
Garage Tait R WA-3651
Takacs Andy Little York R VA-4439
Takacs Helen 1715 W 2nd S FU-4764
Takacs Jno 207 N Western A AD-3937
Takacs Jno Jr 26 N Western A HE-4779
Takacs Joseph 1533 W 2nd S HE-1822
Takagh Jas L 16 Hallwood A AD-3333
Talalay Anselm 565 W 2nd S FU-4781
Talbert Mary 58 Louie S FU-9256
Talbot S H 952 Fernvale A RA-2078
Talbot Thomas B Jr Harrier Bg HE-1166
Atty
Residence 1704 Shafor D WA-6579
Talbot Willard E 28 Forrer B WA-5712
Talbott David H 124 Missouri A KE-3917
Talbott Nelson S Ofc 131 N Ludlow S AD-4111
Residence Runnymeade R WA-2142
Talbott Realty Co 131 N Ludlow S AD-4111
Talbott Refin A 334 Sprague S AD-8544
Talbott Wm R 1942 Malvern A RA-3360
Taliaferro Harry 3430 Martimont D KE-4377
Tallet Walter E 18 N Jersey S KE-1644
Talley Cleaning Co 235 N Main S FU-9197
Clnrs
Talley Hearchel 1436 Hochhalt A FU-5645
Talley Lavina 238 N Ludlow S AD-5619
Tallmadge also see Talmage
Tallmadge Clarence L 61 Bond S RA-2396
Tallman Ross 301 Kreiger A FU-0799

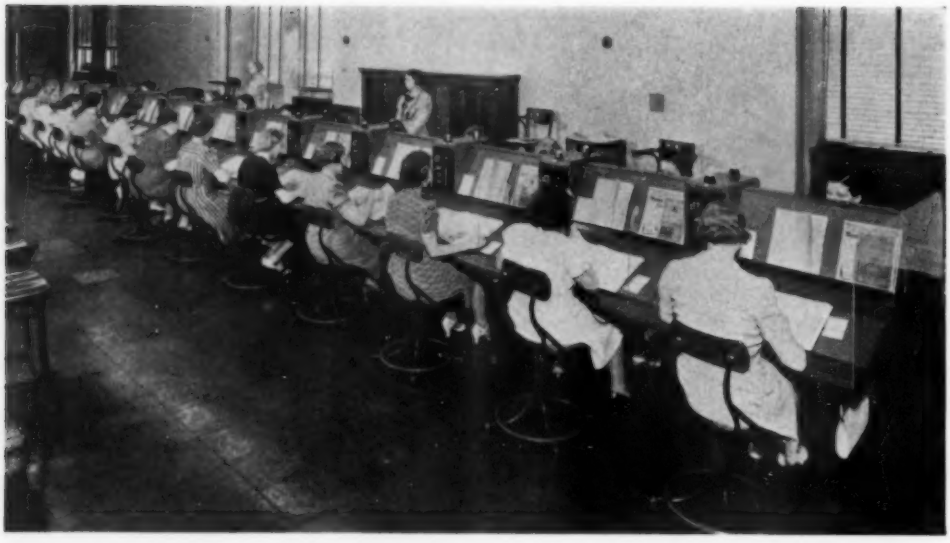
A SECTION OF ROTARY FILE

This is a section of one of the files shown of the opposite page, indicating how the individual listings may be inserted or removed to keep the files up to date

The Information Operator

WHILE improved methods and equipment provide the means, it is the operator who is responsible for giving the service; and if full benefit is to be derived from new developments, it is important that care be taken in the selection and training of Information operators. A student operator selected for Information must be a good speller, of course; she should know the general geography of the community in which she is engaged; and she should be familiar with the different racial names of its inhabitants. Resourcefulness is a characteristic which is important in the Information operator if she really is to be helpful to those who come to her for assistance.

The Information operator's initial training period may take up to two weeks. During this period she is given what might be termed a "tailor-made" course of instruction—a course designed to prepare her for the specific work performed in the bureau to which she is assigned and to assist her in becoming a productive operator through instruction to fit her individual needs. During this initial training period she will learn how to make effective use of her records, the



ANOTHER RECENT DEVELOPMENT IN INFORMATION-BUREAU EQUIPMENT

This type of information desk has been developed for use in localities where relatively few records are required. In all other respects its operation is the same as the other modern information equipment pictured on the preceding pages

normal limits of search which have been found to be most productive, how to handle emergency calls, and many other fundamentals of the job. She will learn that customers are not always listed exactly as asked for by the person calling, and that she must acquire the habit of making suitable suggestions which occur to her as she searches in her records for requested information. She will learn that there are several ways in which the more common names can be spelled which she must be aware of if she expects to make intelligent use of her records. Some examples of these are Petersen, Peterson—Smith, Smyth, Smit—Cohen, Cohan, Coen, Cone, Kohn.

THE initial training period is only the beginning of the Information operator's education; for in this branch of the service, as in others, training is a continuing activity and experience a big factor in the development of proficiency. With experience, she will become familiar with the more frequently called business firms, and will find she is often able to give out their numbers from memory, thereby expediting her report to the person asking. She will learn to associate trade names which are not listed in the directory with the manufacturers or distributors of these products. She will become more proficient in the handling of her records, and will instinctively know which record to use in beginning a search to locate a listing in the shortest possible time. These are only a few of the things experience will develop in an operator, all of which go a long way towards making the service more complete and efficient.

To make the service more pleasing,

operators have been encouraged to use a natural, courteous tone of voice in their contacts with customers. They are given considerable latitude in the choice of operating phrases to fit particular situations, and the degree of liberality which is permitted in this connection has been effective in promoting an atmosphere of personal service.

Information Trends

THE effect of introducing improved methods and equipment in Information has been reflected in a substantial reduction in the average interval of time required to handle an Information call. In some of the larger cities, this interval has been cut almost in half. There is evidence, however, that this situation has encouraged the use of Information service to a point where some customers are using it as a first source of reference, rather than as the secondary source for which it is intended. In 1940, over half the Information calls handled in the Bell System were for telephones correctly listed in the directory, and as the volume of these calls increases, major problems are created. A great deal of thought is given to making the thirty million directories printed each year as satisfactory to customers as possible,* and it is considered not unreasonable to expect customers to refer to them before calling upon Information for assistance.

The purpose of Information is to provide customers with telephone numbers which do not appear in the current directory, and to assist telephone users who may be having difficulty in locating people they wish to call. In the fulfillment of this purpose, it is the desire of all those charged with the responsibility of the service to do the job thoroughly, efficiently, and in a manner which will merit the approval of those customers who have occasion to seek the assistance of Information.

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* See "Making Telephone Directories Better," BELL TELEPHONE MAGAZINE, February, 1941.

TELEPHONE STATISTICS OF THE WORLD

The High Development of Facilities and the Frequency of Use of the Service in This Country, as Contrasted with the Rest of the World, Are Revealed in This Annual Survey

By KNUD FICK

THE latest issue of "Telephone and Telegraph Statistics of the World" illustrates in detail and in summary form, in its eight pages of charts and tables, the statistical situation in respect of wire communication throughout the world as of January 1, 1940. As in former years, this survey has been undertaken by the Chief Statistician's Division of the American Telephone and Telegraph Company, with the coöperation of the government administrations and the private companies which own and operate the various component parts of the world's vast network of telephone and telegraph facilities. In the compilation of the present edition of this bulletin, however, it proved impossible to obtain authentic statistics covering developments during 1939 for many of the foreign countries now involved in the war. But the latest statistics previously available are included for such countries, so that the tables and charts in the bulletin, which are reprinted here, are substantially accurate and representative of the status of world telephone facilities at the beginning of 1940.

As of that date, there were 42,642,252 telephones in service throughout the world, half of them—20,830,950—in the United States and about a third—15,765,994—in Europe. Connecting with these 42,642,252 telephones were 179,110,000 miles of exchange and long distance wire conductors, again with about one half—95,150,000 miles—in the Unitd States and one third—60,611,000 miles—in Europe. The indicated net gain in telephones during 1939 was 1,551,905, or 3.8 per cent, while the world's telephone wire increased by 4,562,000 conductor miles, a gain of 2.6 per cent. The relative telephone development of the United States can be seen from the following brief comparison:

	Telephones		Telephone Wire		
	Number	Per 100 Pop.	Miles	Per 100 Pop.	Per Telephone
United States	20,830,950	15.85	95,150,000	72.41	4.57
Rest of World	21,811,302	1.07	83,960,000	4.13	3.85
Total World	42,642,252	1.97	179,110,000	8.27	4.20

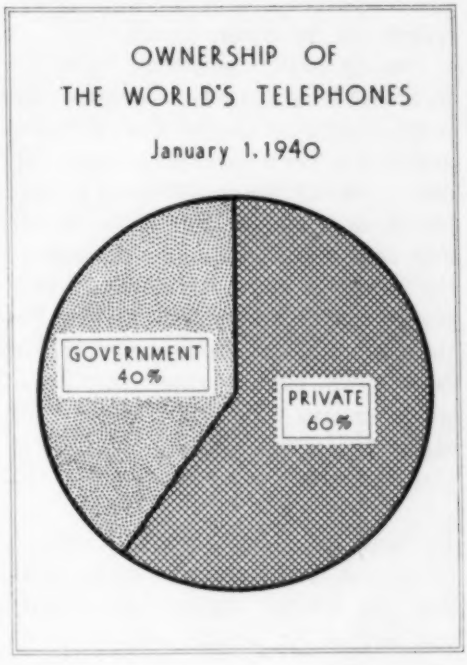
At the beginning of 1914, just before the first World War, a similar statement of this country's relative position would have shown:

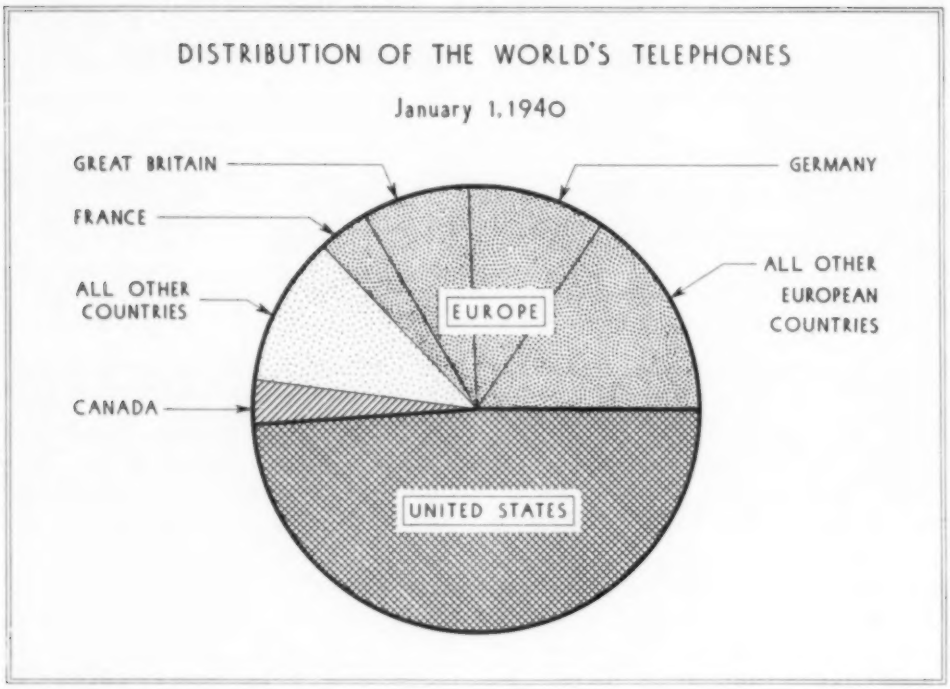
	Telephones		Telephone Wire		
	Number	Per 100 Pop.	Miles	Per 100 Pop.	Per Telephone
United States	9,542,017	9.68	22,137,000	22.46	2.32
Rest of World	5,346,533	0.32	15,201,000	0.92	2.84
Total World	14,888,550	0.85	37,338,000	2.14	2.51

At the present time (i.e., the middle of 1941), it may be estimated that there are at least 45,000,000 telephones in service throughout the world, slightly over half of them being in the United States, indicating that the world's telephones have about trebled since the first World War. The world's telephone wire mileage is now five times greater than it was in 1914. In less than 28 years, the United States alone has added some 13 million telephones and nearly 80 million miles of wire to its telephone network.

At the beginning of 1940, nearly 24 million—or 56 per cent—of the world's telephones were of the dial type, including 10,350,864 dial telephones in this country. More than half of the world's dial telephones were placed in service during the decade from 1930 to 1940, the gain in dial installations having been slightly greater than net telephone gain during this period.

THREE-FIFTHS of all the telephones in the world are operated under private enterprise. It is interesting in this connection to compare the telephone development in the largest private (or predominantly private) systems (United States, Canada, Italy and Denmark) with that in the largest wholly government operated systems (Germany, Great Britain, France and Japan). Private initiative has produced an average of 12 telephones per 100 people in the former countries, or three times the telephone development in the largest four telephone systems operating under government auspices. The bulk (nearly 81 per cent) of the world's 17,072,092 government-operated telephones are





in Europe, whereas 99 per cent of all the telephones in the Western Hemisphere are in private hands.

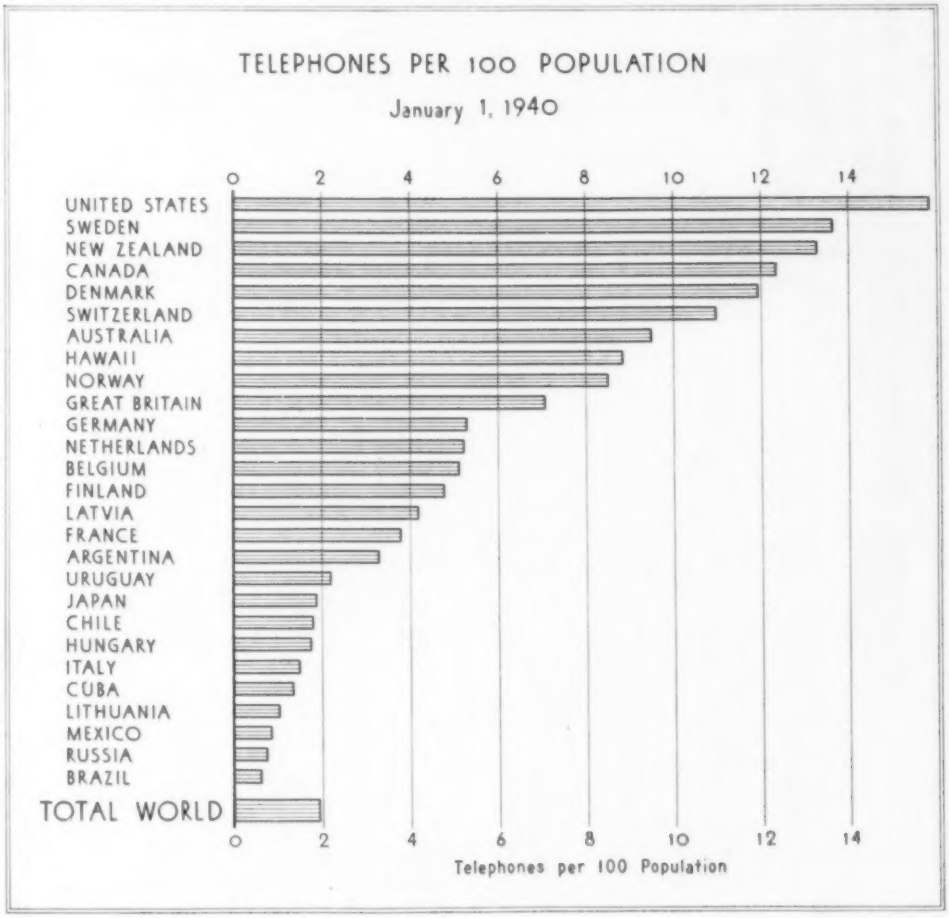
During 1939, more than 30 billion local and long distance telephone calls were completed in the United States and it has been estimated, from records covering the majority of foreign telephone systems, that some 60 billion calls were completed throughout the world at large, or about 28 telephone conversations per capita. For the United States alone, however, the per capita calling rate was 231.5, which means that there were only about 15 calls per capita outside the United States.

IT will be seen from the various tables and charts reproduced herewith that the United States—with nearly one half of the world's telephones on January 1, 1940, but with only six per cent of its population—has retained its supremacy as the world's leading country in the field of voice communication.

In point of absolute size, the next largest national telephone system is that of the German Reich (including Austria and Sudetenland). On June 30, 1939, this embraced 4,226,504 telephones interconnected by some 18 million miles of wire, these facilities representing some 10 per cent of the respective world totals. The over-all German telephone development, however, was equivalent to only 5.28 telephones per 100 people, which is a little less than one half the average telephone development of the smaller communities and rural areas in the United States. At the beginning of 1940, there was, in fact, an average of

11.33 telephones for every 100 people in American communities with a population of 50,000 or less. This is a relative telephone development better than that to be found in the vast majority of cities, even the great national capitals, abroad. In most of the larger German cities, for example, there were fewer than 10 telephones for every 100 people, the exception being Berlin, where the 599,911 telephones on March 31, 1939, corresponded to somewhat less than 14 per cent of the population.

The second largest network of telephone facilities abroad is that of Great Britain and Northern Ireland, embracing on March 31, 1940, 3,375,902 telephones and over 16 million miles of telephone wire. This corresponded to 7.06 telephones and 34.10 miles of telephone wire per 100 population. Operated as a branch of the British Post Office (except for three small systems serving the City of Hull and the Islands of Guernsey and Jersey), the British telephone system is the best developed system among the larger European countries. The British system handles some 2,255,000,-

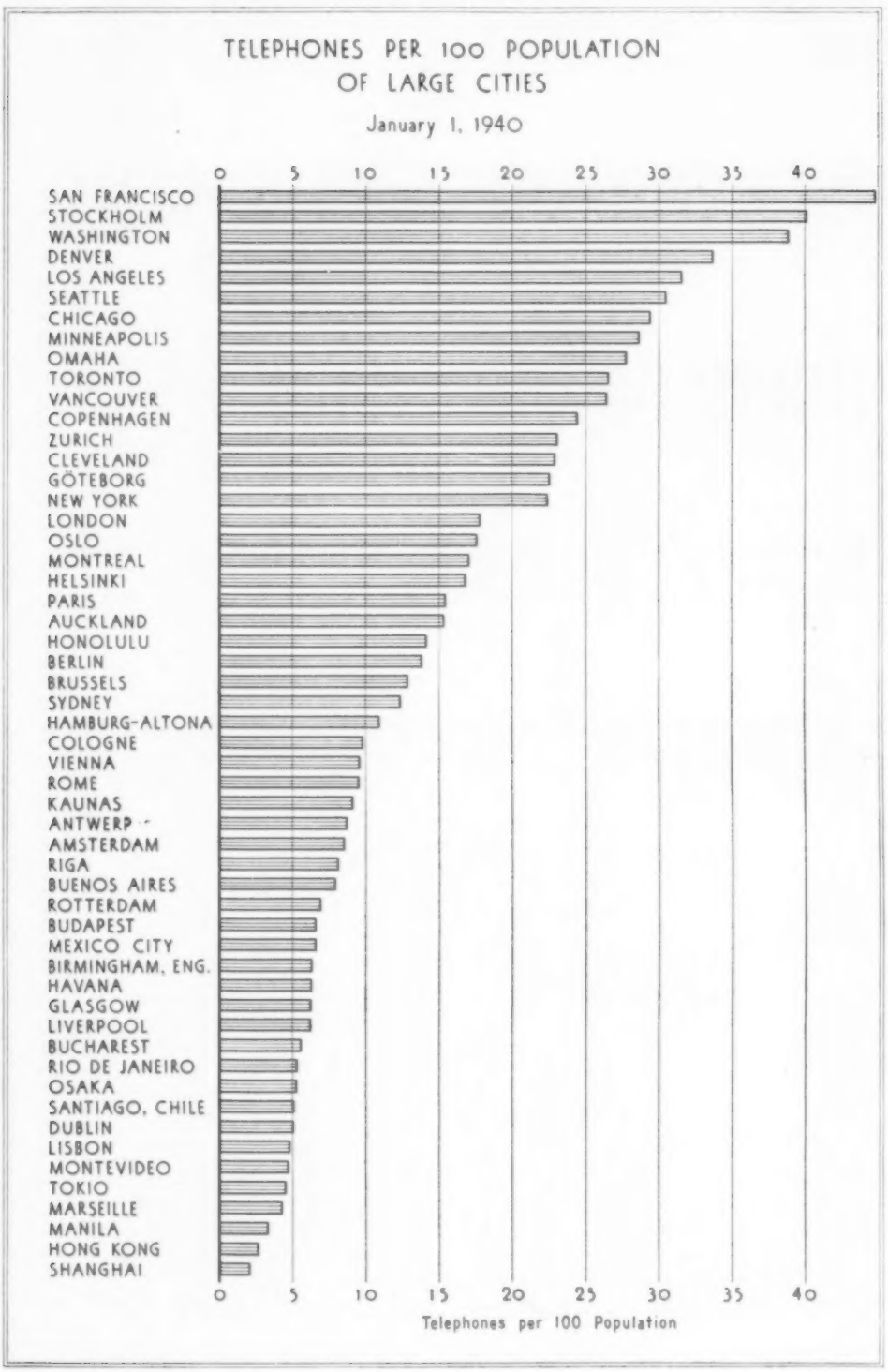


TELEPHONE DEVELOPMENT OF THE WORLD, BY COUNTRIES, JANUARY 1, 1940

Countries	Number of Telephones: Government Systems	Number of Telephones: Private Companies	Number of Telephones: Total	Per Cent of Total World	Telephones Per 100 Population
NORTH AMERICA:					
United States	—	20,830,950	20,830,950	48.85%	15.85
Canada	212,619	1,184,653	1,397,272	3.28%	12.35
Central America	13,799	18,881	32,680	.08%	0.39
Mexico	1,337	174,263	175,600	.41%	0.88
West Indies—					
Cuba	610	56,462	57,072	.13%	1.33
Puerto Rico	531	16,227	16,758	.04%	0.90
Other Places in the West Indies	9,785	19,502	29,287	.07%	0.36
Other Places in North America	—	19,108	19,108	.04%	4.87
Total	238,681	22,320,046	22,558,727	52.90%	12.16
SOUTH AMERICA:					
Argentina	—	434,017	434,017	1.02%	3.30
Bolivia	—	2,611	2,611	.006%	0.08
Brazil	1,291	271,437	272,728	.64%	0.62
Chile	—	84,151	84,151	.20%	1.80
Colombia	8,900	32,787	41,687	.10%	0.47
Ecuador	4,600	3,050	7,650	.02%	0.27
Paraguay	—	3,658	3,658	.01%	0.38
Peru	—	32,286	32,286	.07%	0.48
Uruguay†	34,810	11,846	46,656	.11%	2.20
Venezuela	740	27,910	28,650	.07%	0.80
Other Places in South America†	3,018	—	3,018	.007%	0.54
Total	53,359	903,753	957,112	2.25%	1.05
EUROPE:					
Belgium	430,000	—	430,000	1.01%	5.12
Bulgaria	31,225	—	31,225	.07%	0.48
Denmark	17,813	441,944	459,757	1.08%	11.95
Eire #	45,513	—	45,513	.11%	1.54
Finland†	7,720	177,736	185,456	.43%	4.79
France†	1,589,595	—	1,589,595	3.73%	3.79
Germany*	4,226,504	—	4,226,504	9.91%	5.28
Great Britain and No. Ireland #	3,375,902	—	3,375,902	7.92%	7.06
Greece	5,967	48,437	54,404	.13%	0.76
Hungary	178,325	790	179,115	.42%	1.76

Italy*	—	650,000	650,000	1.52%	1.49
Latvia##	83,650	—	83,650	.20%	4.20
Lithuania†	26,591	—	26,591	.06%	1.03
Netherlands	460,000	—	460,000	1.08%	5.22
Norway*	153,000	97,000	250,000	.59%	8.52
Portugal	20,366	52,506	72,872	.17%	0.94
Roumania	—	102,268	102,268	.24%	0.51
Russia¶	1,272,500	—	1,272,500	2.98%	0.75
Spain	—	300,000	300,000	.70%	1.18
Sweden	863,102	1,697	864,799	2.03%	13.64
Switzerland	462,013	—	462,013	1.08%	10.99
Yugoslavia	72,000	—	72,000	.17%	0.45
Other Places in Europe	437,253	134,577	571,830	1.34%	1.11
Total	13,759,039	2,006,955	15,765,994	36.97%	2.74
ASIA:					
British India##	31,878	51,500	83,378	.20%	0.02
China	45,000	115,000	160,000	.37%	0.04
Japan##	1,367,958	—	1,367,958	3.21%	1.89
Other Places in Asia	211,129	99,034	310,163	.73%	0.15
Total	1,655,965	265,534	1,921,499	4.51%	0.18
AFRICA:					
Egypt	67,983	—	67,983	.16%	0.30
Union of South Africa#	220,288	—	220,288	.52%	2.13
Other Places in Africa	140,968	1,460	142,428	.33%	0.11
Total	429,239	1,460	430,699	1.01%	0.27
OCEANIA:					
Australia*	661,996	—	661,996	1.55%	9.51
Hawaii	—	37,154	37,154	.09%	8.78
Netherlands Indies	48,321	4,492	52,813	.12%	0.08
New Zealand#	217,869	—	217,869	.51%	13.28
Philippine Islands	2,410	30,386	32,796	.08%	0.20
Other Places in Oceania	5,213	380	5,593	.01%	0.25
Total	935,809	72,412	1,008,221	2.36%	1.03
TOTAL WORLD	17,072,092	25,570,160	42,642,252§	100.00%	1.97

† January 1, 1939. ## March 31, 1939. * June 30, 1939. # March 31, 1940.
¶ U.S.S.R., including Siberia and Associated Republics, January 1, 1939.
§ Approximately 56% of this total are automatic or "dial" telephones, including 10,351,000 "dial" telephones in the United States.


TELEPHONES PER 100 POPULATION
OF LARGE CITIES
January 1, 1940
0 5 10 15 20 25 30 35 40
SAN FRANCISCO
STOCKHOLM
WASHINGTON
DENVER
LOS ANGELES
SEATTLE
CHICAGO
MINNEAPOLIS
OMAHA
TORONTO
VANCOUVER
COPENHAGEN
ZURICH
CLEVELAND
GÖTEBORG
NEW YORK
LONDON
OSLO
MONTREAL
HELSINKI
PARIS
AUCKLAND
HONOLULU
BERLIN
BRUSSELS
SYDNEY
HAMBURG-ALTONA
COLOGNE
VIENNA
ROME
KAUNAS
ANTWERP
AMSTERDAM
RIGA
BUENOS AIRES
ROTTERDAM
BUDAPEST
MEXICO CITY
BIRMINGHAM, ENG.
HAVANA
GLASGOW
LIVERPOOL
BUCHAREST
RIO DE JANEIRO
OSAKA
SANTIAGO, CHILE
DUBLIN
LISBON
MONTEVIDEO
TOKIO
MARSEILLE
MANILA
HONG KONG
SHANGHAI
0 5 10 15 20 25 30 35 40
Telephones per 100 Population

000 telephone messages per year, an average per capita telephone usage (47.4 messages in 1938) which is still considerably below either the Scandinavian or North American calling rates. The telephone development of British cities is similar to that found in Germany and France, averaging around 8 or 9 telephones per 100 people. London, however, had 17.81 telephones for every 100 inhabitants of the city and county of London proper, although Greater London, with nearly nine million people and well over one million telephones, averaged less than 13 telephones per 100 inhabitants.

THE French telephone system, operated by the Government Administration of Posts, Telegraphs and Telephones, had 1,589,595 telephones on January 1, 1939, or less than 4 per 100 population, with a wire mileage of 14.35 per 100 population. Although no less than 28 per cent of all French telephones are to be found in Paris, the telephone development of the French capital was only 15.45 per 100 inhabitants; other French cities are considerably less developed telephonically. The average French citizen uses the telephone only some 23 times during the year, or just about one tenth as much as the use in the United States.

The three countries of Canada, Japan, and Soviet Russia all had approximately the same number of telephones (1,397,272, 1,367,958 and 1,272,500, respectively). But Canada, where all but about 15 per cent of the telephones are owned and operated by private companies, had a development equivalent to 12.35 telephones per 100 population, which was six times better than that of Japan and 16 times better than that of Russia. Both of the latter countries operate their telephone systems as a function of the Government.

IN proportion to their respective populations, the telephonically best developed territories—outside the North American continent—are the three Scandinavian countries and Switzerland, in Europe; Australia; Hawaii; and New Zealand. In all of these, the number of telephones in service corresponded to between 8 and 13 per cent of the population. In Denmark and Hawaii, all or nearly all of the telephone facilities are privately operated. In Norway, over one third are under private operation, and Sweden gained her position of telephonic preëminence in Europe during the period when the telephone system was still largely in private hands. Australia's and New Zealand's large cities have telephone developments of from 10 to 20 telephones per 100 inhabitants, and the larger cities in Scandinavia and Switzerland likewise are fairly well provided with telephone facilities. Stockholm, an exceptional instance, had 40.16 telephones for every 100 of its 460,000 inhabitants.

LEAVING Russia out of the computation, Europe covers nearly two million square miles, as compared with three million in the United States, but Europe's population of 400 million is three times that of the United States. Considering the fact, then, that Europe is, on the average, about four

TELEPHONE DEVELOPMENT OF LARGE CITIES, JANUARY 1, 1940

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones Per 100 Population
ARGENTINA:			
Buenos Aires	3,400,000	268,956	7.91
AUSTRALIA:†			
Adelaide	321,000	35,935	11.19
Brisbane	326,000	35,805	10.98
Melbourne	1,036,000	135,518	13.08
Sydney	1,289,000	159,825	12.40
BELGIUM:††			
Antwerp	560,000	48,696	8.70
Brussels	991,000	127,639	12.88
Liege	433,000	29,885	6.90
BRAZIL:			
Rio de Janeiro	1,940,000	103,797	5.35
CANADA:			
Montreal	1,095,000	187,158	17.09
Ottawa	203,200	40,829	20.09
Toronto	807,900	214,782	26.59
Vancouver	292,000	77,362	26.49
CHILE:			
Santiago	860,000	44,487	5.17
CHINA:			
Hong Kong	850,000	22,606	2.66
Shanghai≠	3,750,000	79,554	2.12
CUBA:			
Havana	725,000	45,651	6.30
DENMARK:			
Copenhagen	900,000	220,202	24.47
EIRE:#			
Dublin	488,000	24,893	5.10
FINLAND:†			
Helsinki	305,000	51,328	16.83
FRANCE:†			
Bordeaux	260,000	23,311	8.97
Lille	200,000	18,566	9.28
Milan	1,206,000	109,168	9.05
Naples	920,000	31,373	3.41
Rome	1,280,000	122,442	9.57
Venice	284,000	10,209	3.59
JAPAN:##			
Kobe	989,000	46,265	4.68
Kyoto	1,160,000	51,457	4.44
Nagoya	1,224,000	46,122	3.77
Osaka	3,321,000	176,697	5.32
Tokio	6,458,000	290,510	4.50
LATVIA:##			
Riga	391,000	31,795	8.13
LITHUANIA:†			
Kaunas	110,000	10,124	9.20
MEXICO:			
Mexico City	1,450,000	95,673	6.60
NETHERLANDS:†			
Amsterdam	794,000	67,927	8.56
Haarlem	174,000	14,474	8.32
Rotterdam	635,000	44,145	6.95
The Hague	540,000	57,635	10.67
NEW ZEALAND:			
Auckland	215,000	33,012	15.35
Wellington	160,000	32,083	20.05
NORWAY:*			
Oslo	417,000	73,786	17.69
PHILIPPINE ISLANDS:			
Manila	770,000	25,715	3.34
PORTUGAL:			
Lisbon	710,000	33,902	4.78
ROUMANIA:			
Bucharest	910,000	50,347	5.53

Lyon	650,000	39,369	6.06
Marseille	915,000	38,801	4.24
Paris	2,830,000	437,139	15.45
GERMANY:##			
Berlin	4,339,000	599,911	13.83
Breslau	623,000	48,203	7.74
Cologne	771,000	75,393	9.78
Dresden	821,000	75,569	9.21
Dortmund	585,000	28,945	4.95
Essen	672,000	36,743	5.47
Frankfort-on-Main	647,000	68,112	10.52
Hamburg-Altona	1,724,000	188,861	10.96
Leipzig	767,000	73,959	9.64
Munich	866,000	97,215	11.23
Vienna	1,874,000	180,165	9.61
GREAT BRITAIN & NO. IRELAND:##			
Belfast	415,000	23,336	5.62
Birmingham	1,259,000	79,847	6.34
Bristol	450,000	31,376	6.97
Edinburgh	465,000	47,066	10.12
Glasgow	1,150,000	72,359	6.29
Hull#	361,000	25,354	7.02
Leeds	568,000	36,825	6.48
Liverpool	1,265,000	79,228	6.26
London— (City and County of London)	4,028,000	717,468	17.81
Manchester	1,015,000	68,191	6.72
Newcastle	482,000	28,167	5.84
Sheffield	522,000	28,776	5.51
HAWAII:			
Honolulu	179,000	25,408	14.19
HUNGARY:†			
Budapest	1,635,000	107,906	6.60
Szeged	141,000	2,635	1.87
ITALY:†			
Bologna	315,000	14,738	4.68
SWEDEN:			
Göteborg	281,000	63,585	22.63
Malmö	155,000	29,862	19.27
Stockholm	460,000	184,722	40.16
SWITZERLAND:			
Basel	165,000	38,916	23.59
Bern	125,000	31,662	25.33
Geneva	125,000	30,950	24.76
Zurich	320,000	73,914	23.10
URUGUAY:†			
Montevideo	705,000	33,447	4.74
UNITED STATES: (See Note)			
New York	7,442,000	1,669,904	22.44
Chicago	3,390,000	997,174	29.42
Los Angeles	1,444,000	456,564	31.62
Cleveland	1,153,900	264,560	22.93
Total 6 Exchange Areas with over 1,000,000 Population	17,245,900	4,191,428	24.30
Milwaukee	748,700	162,758	21.74
San Francisco	648,800	290,990	44.85
Washington	654,000	254,042	38.84
Minneapolis	541,000	155,362	28.72
Total 13 Exchange Areas with 500,000 to 1,000,000 Population	8,922,900	2,265,558	25.39
Seattle	422,000	128,613	30.48
Denver	321,500	108,244	33.67
Omaha	246,600	68,452	27.76
Hartford	242,700	67,685	27.89
Total 30 Exchange Areas with 200,000 to 500,000 Population	9,503,500	2,210,282	23.26
Total 49 Exchange Areas with over 200,000 Population	35,672,300	8,667,268	24.30

NOTE: There are shown, for purposes of comparison with cities in other countries, the total development of all cities in the United States in certain population groups, and the development of certain representative cities within each of such groups.

* June 30, 1939.
≠ International Settlement and French Concession.
March 31, 1939.
†† February 28, 1938.
# March 31, 1940.
† January 1, 1939.

TELEPHONE CONVERSATIONS AND TELEGRAMS, YEAR 1939

Country	Number of Telephone Conversations	Number of Telegrams	Total Number of Wire Communications	Per Cent of Total Wire Communications		Wire Communications Per Capita		
				Telephone Conversations	Telegrams	Telephone Conversations	Telegrams	Total
Australia	637,000,000	17,998,000	654,998,000	97.3	2.7	91.9	2.6	94.5
Belgium†	320,000,000	5,900,000	325,900,000	98.2	1.8	38.5	0.7	39.2
Canada	2,774,000,000	11,629,000	2,785,629,000	99.6	0.4	246.3	1.0	247.3
Denmark	726,000,000	1,748,000	727,748,000	99.8	0.2	189.5	0.5	190.0
Finland†	309,000,000	811,000	309,811,000	99.7	0.3	80.3	0.2	80.5
France†	972,000,000	27,524,000	999,524,000	97.2	2.8	23.2	0.6	23.8
Germany†	3,640,000,000	21,701,000	3,661,701,000	99.4	0.6	45.8	0.3	46.1
Gt. Britain & No. Ireland†	2,255,000,000	59,484,000	2,314,484,000	97.4	2.6	47.4	1.3	48.7
Hungary†	187,000,000	2,439,000	189,439,000	98.7	1.3	19.5	0.3	19.8
Japan†	5,339,000,000	68,475,000	5,407,475,000	98.7	1.3	74.2	0.9	75.1
Netherlands†	468,000,000	3,588,000	471,588,000	99.2	0.8	53.9	0.4	54.3
Norway†	281,000,000	3,489,000	284,489,000	98.8	1.2	96.1	1.2	97.3
Sweden	1,195,000,000	4,641,000	1,199,641,000	99.6	0.4	189.0	0.7	189.7
Switzerland	335,000,000	2,039,000	337,039,000	99.4	0.6	79.8	0.5	80.3
Union of South Africa	317,000,000	6,863,000	323,863,000	97.9	2.1	30.9	0.7	31.6
United States	30,300,000,000	195,000,000	30,495,000,000	99.4	0.6	231.5	1.5	233.0

NOTE: Telephone conversations represent completed local and toll or long distance messages. Telegrams include inland and outgoing international messages.
† Year 1938.

and a half times as densely populated as the United States, one would expect a more uniform development of telephone service in European communities outside the largest cities than would be the case in similar American areas, where the much sparser average settlement would seemingly make the provision of adequate telephone facilities a more difficult problem. According to the latest available information, however, the greatest discrepancy in the telephone development of Europe as compared with that in the United States occurs in non-metropolitan areas; viz.:

	Telephones per 100 Population		
	Europe	United States	Ratio of U. S. to Europe
Cities with a population of over 1,000,000	10.1	24.3	2.4 to 1
500,000–1,000,000	8.9	25.4	2.9 to 1
200,000– 500,000	6.8	23.3	3.4 to 1
Total metropolitan areas	8.9	24.3	2.7 to 1
Rural areas and communities with less than 200,000 population	2.4	12.7	5.3 to 1
Total	3.6	15.9	4.4 to 1

In relation to population, the large cities of the United States have generally from two to four times as many telephone facilities as European cities, while our smaller cities and rural areas have over five times the telephone facilities of similar communities in Europe.

FOR THE RECORD

DIRECT RADIO TELEPHONE CIRCUITS TO PORTUGAL AND PANAMA ESTABLISHED

A DIRECT radio telephone circuit between New York and Lisbon, Portugal, was opened on June 25. Previous to the opening of this circuit, calls from the United States to Portugal had passed over the New York-Madrid radio telephone circuit, completing their journey to Portugal over long distance wire lines. The service linking Bell and Bell-connecting telephones in this country with those in Portugal is operated between the American Telephone and Telegraph Company's short wave stations in New Jersey and the Portuguese Marconi Company's radio telephone stations near Lisbon.

A direct radio telephone service between New York and Panama City was opened on July 11. This system provides one circuit initially, with facilities for a second as soon as it is needed. Calls between the United States and Panama and the Canal Zone have more than doubled during the past year. Since 1933, telephone service with Panama has been operated between the A. T. & T. Company's short-wave radio telephone stations near Miami and the radio telephone stations of the Tropical Radio Telegraph Company in Panama Viejo. The new radio circuit operates between the Tropical stations and stations of the A. T. & T. Company in New Jersey.

PROGRESS IS RAPID ON TRANSCONTINENTAL TELEPHONE CABLE

WORK goes forward rapidly on the Bell System's new $20,000,000 transcontinental telephone cable between Omaha, Neb., and Sacramento, Cal., which is to link the eastern and Pacific Coast cable networks, and by the end of July about 500 miles of the twin underground cables had been plowed in by three tractor trains at work along different sections of the route. (See "Trends in Toll Cable Usage," MAGAZINE, May, 1941). About 30 of the approximately 100 repeater-station buildings along the line have already been completed, and the installation of repeaters and of circuit balancing apparatus is under way in more than a score of them.

The two cables are laid side by side in a furrow plowed usually about 30 inches deep. The cables feed off their reels and into the ground through an aperture in the plow share, and the entire operation is completed at one time as the train is drawn along by powerful tractors. While the speed of one of these trains naturally depends on the character of the ground, under particularly favorable conditions one train covered seventeen miles in one week.

The circuits in one of the twin cables will carry words bound eastward, while those in the other will carry the westbound halves of conversations. For the most part, the cables are manufactured and laid in lengths of about 3,000 feet, and gangs are now engaged in splicing the lengths together and conducting tests. Gas pressure is maintained in the cables during the laying operation, and the pressure is tested after each length is in place, to determine that no opening in the lead sheath has occurred during the plowing in. For protection, the route follows a carefully selected right-of-way which avoids highways.

The new cable will supplement several transcontinental lines which consist in part of open wire. According to present plans, from 50 to 70 circuits will be put into service in the completed section between Laramie, Wyo., and Omaha before the end of this year. When the rest of the cable is finished, next year, there will be about 100 circuits to link the eastern and western cable networks at Omaha and Sacramento respectively, and an additional 20 or more to take care of traffic between Denver and the east. This will be an increase of about 50 per cent over the number of circuits provided by existing transcontinental lines. It is expected that ultimately this one cable alone will furnish some 600 telephone circuits, or about triple the present number of transcontinental circuits. Channels will also be provided for radio network transmission and for telegraph and teletypewriter purposes.

CONTRIBUTORS TO THIS ISSUE

A 1937 graduate of Wesleyan University, ALVIN VON AUW stayed on at the University to take his M.A. in 1938. Until April of 1939 he served as managing editor of *Listeners Digest*, a national magazine featuring condensed versions of notable radio broadcasts. When *Scribner's Commentator* took over the *Listeners Digest* formula, Mr. von Auw became radio editor of the combined publication. He joined Western Electric's Public Relations Department in July of 1939, and has since contributed numerous articles to trade and general publications on such subjects as broadcasting, aviation radio, marine radio, public address systems, and sound motion pictures. During recent months he has written a series of articles for Western Electric's employee papers, designed to keep the Company's employees informed on the extent of the Western's contribution to the Bell System's and the nation's defense efforts.

ENTERING Harvard in 1916, EUSTACE FLORANCE left college in 1917 to serve as a First Lieutenant and Captain of Infantry in several southern cantonments until the middle of 1919. In 1921 he joined the Chesapeake and Potomac Telephone Companies in Washington, where he was engaged in commercial engineering work. In 1926 he was appointed Division Commercial Supervisor of the Washington Division, and in 1929 General Commercial Manager of the Chesapeake and Potomac Telephone Company of Baltimore City, serving the State of Maryland. In May of 1936 he returned to Washington, headquarters of the companies, as General Information Manager.

GRADUATED from the University of Kansas in 1915, AUSTIN BAILEY received his Ph.D. degree from Cornell University in 1920, after having served during the World War as a Second Lieutenant in the

Signal Corps, assigned to the radio laboratories at Camp Alfred Vail (now Fort Monmouth). In 1920 he accepted a position as superintendent of the apparatus division of Corning Glass Works, leaving this in the Fall of 1921 to become Assistant Professor of Physics at the University of Kansas. He joined the Bell System in 1922, his first assignment being on radio problems in the Department of Development and Research of the American Telephone and Telegraph Company. Dr. Bailey was sent to England and Scotland in 1926 for a year's work in connection with the establishment of the first commercial transatlantic radio telephone circuit. In 1934 he was transferred to the Bell Telephone Laboratories, where he continued with the development of radio for Bell System applications. In 1937 he returned to the A. T. and T. Company, in the Department of Operation and Engineering, where he has since been engaged with the technical aspects of numerous radio projects, such as ship to shore, overseas, emergency, point to point, and vehicular services. He has contributed several articles to the *Bell System Technical Journal*, *Bell Laboratories Record*, and BELL TELEPHONE QUARTERLY, all dealing with various aspects of radio telephony.

AFTER graduating from the Massachusetts Institute of Technology with the degrees of B.S. in E.E. in 1909, M.S. in 1910, and Sc.D. in 1911, REGINALD L. JONES became a member of the research staff of the Western Electric Company, engaged in study of the fundamental characteristics of telephone transmitters and receivers and of mechanical telephone repeaters. In 1914 he was placed in charge of the Transmission Research Department, organizing and directing early studies of the nature of speech and hearing; development studies of improved transmitters, receivers, and loud speakers; and transmission engineering of telephone systems. In 1917–18 he was a Captain in the Signal Corps Reserves, assigned to research work for the Army and Navy relating to acoustic instruments and submarine signaling. In 1923 he was placed in charge of the Inspection Engineering Department, newly organized to establish a scientific basis for inspection operations in factory and field. When the Bell Telephone Laboratories was organized, in 1925, Dr. Jones continued in this work in the new organization. In 1927 the Outside Plant Development Department was added to his responsibilities. He organized the first laboratories devoted exclusively to the development and specification of materials and constructions used in the outside plant of the Bell System. In 1928 he became Director of Apparatus Development. This department is responsible for investigation and design of most of the apparatus and materials used by the Bell System. He is a representative of the telephone group on the Standards Council of the American Standards Association, and is the Bell System representative on the Aviation Communications Sub-committee of the Defense Communications Board. He is a member of the Bell System Committee on Critical Materials, and is chairman of the Benefit Committee of the Bell Telephone Laboratories.

UPON graduation from Brown University with the B.S. degree in 1922, FRED C. BAURENFEIND joined the New York Telephone Company, and in the next several years filled a number of assignments in the traffic field organization in New York City. In 1930 he was appointed District Traffic Superintendent of the Washington Heights district; in 1932, after a brief period during which he was in charge of traffic instruction work for men in dial panel operation, he became District Traffic Superintendent for Information bureaus in Manhattan, with a personnel of about 1,000; and in 1938 he was made Traffic Superintendent of the Circle dial-

toll district. Last November he was transferred to the Department of Operation and Engineering of the A. T. and T. Company, where, in the Traffic Division, he is engaged on local and auxiliary service matters—which include, among others, the Information service.

BORN in Denmark, KNUD FICK was graduated in 1916 from Hellerup Gymnasium, near Copenhagen, with a degree corresponding to Bachelor of Arts, supplementing this two years later with the degree of Candidate of Philosophy from the University of Copenhagen. Following a number of years in the Foreign Office and other branches of the Danish Government, he joined the American Telephone and Telegraph Company in 1925. In the Chief Statistician's Division of the Comptroller's Department he has been in charge of statistics and economics relating to foreign telephone development. In 1932 he was sent to Madrid, Spain, and in 1938 to Cairo, Egypt, in connection with work for the International Telecommunication Conferences. His present discussion of what statistical analysis reveals about the world telephone situation is his seventh annual contribution to the MAGAZINE and its predecessor on this topic.